ETHICAL PESTICIDE POLICY: BEYOND RISK ASSESSMENT

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Abstract

This thesis sets out to develop a pesticide policy process that is ethical, one that fairly addresses the needs of society whilst at the same time minimizing the impact of pesticides on nature. The process that is developed here is context dependent: it is not a prescription for all public policy processes, but one specifically for pesticides in one country at a particular period in time. Nevertheless, the general principles are widely applicable to other areas of policy, particularly those involving technological risks, and to other countries. Much of the material used is drawn from the New Zealand experience, with two major exceptions: United States data is used to describe the toxicological risk assessment process and its failures, and studies conducted in Asia are used to illustrate community participatory research. The development of Auckland City's Weed Management Policy is used to illustrate the potential of the proposed approach to pesticide policy.

It is argued that the reductionist science of toxicology, on which current pesticide policy heavily depends, fails to accurately predict the effects of pesticides on human health and on the environment. It is shown to be based on a particular set of values that cannot be said to represent those of society in general. These two factors contribute significantly to the differences in the acceptability of risks from pesticides by lay people and by technical experts. There are also gender and race differences in assessment of risk.

It is argued that to base pesticide policy on toxicology is irrational because this science fails to incorporate ecological rationality, i.e. the interconnectedness of nature, and social rationality. It is also argued that pesticide policy based on the anthropocentric approach of the domination of nature, which broadly underlies the mechanistic worldview of science, is unethical because it fails to take into account the needs and interests of nonhuman nature. Ethical pesticide policy is therefore based on ecological rationality (as well as social rationality) and a recognition of the intrinsic interests of nature, both aspects of an ecocentric ethic. The ecocentric ethic is practically applied to pesticide policy processes by using the decision rule of the principle of minimum harm, which is an expression of the precautionary approach.

The objectivity and cultural authority of science are challenged and the way is cleared for the introduction of other knowledge into the ethical pesticide policy process. It is scientism, not science that is rejected, and science takes its place alongside other knowledge systems. Wisdom is incorporated into the policy process by including the knowledge of members of the community and of public interest groups who have

understanding and experience of the effects of pesticides, and also the management of pest, weeds and disease in agri-ecosystems in ways that minimize harm to nonhuman nature, principally by the methods of organic agriculture and natural farming.

Democracy is improved by including in the decision-making those who lie in the path of the policy: public interest groups that bring expertise, experience, and social values, farming interest groups that bring the views of those who use pesticides and those who manage the agri-ecosystem without them, and the appropriate bureaucrats. The pesticide industry is not included in the decision-making group for ethical reasons. The tripartite approach is augmented by a person representing the interests of nonhuman nature, an ecocentrist whose role it is to ensure that the principle of minimum harm is adequately applied. This is an acknowledgement of the need for considerable attitudinal change, particularly on the part of bureaucrats and pesticide users, in order that the ethical pesticide policy process lives up to its potential. Distributional justice issues are addressed by requiring that the policy decision-making group consists of 50 percent women/50 percent men, and 50 percent pakeha/50 percent Maori, to reflect firstly the gender differences in the acceptability of risks from pesticides, and secondly the bi-cultural nature of New Zealand as afforded by the nation's founding legal document, the Treaty of Waitangi.

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Abbreviations

ACVM	Agricultural Compounds and Veterinary Medicines: - Act 1997 - Group - Unit
ADI	acceptable daily intake
ADE	acceptable daily exposure
AGCARM	Agricultural Chemical and Animal Remedies Manufacturers Assoc.
AVMAC	Agricultural Compounds and Veterinary Medicines Advisory Group
BOD	biological oxygen demand
CACO	Chief Agricultural Compounds Officer, Ministry of Agriculture
CDI	chronic daily intake
CNS	central nervous system
COD	chemical oxygen demand
DDT	Dichlorodiphenyltrichloroethane, an organochlorine insecticide
DES	diethylstilbesterol
DoC	Department of Conservation
EC50	environmental concentration of a pesticide required to kill 50 percent of a test population
EDSTAC	Endocrine Disruptor Screening and Testing Advisory Committee
ERMA	Environmental Risk Management Authority
FMFAF	Federal Ministry of Food, Agriculture and Forestry, Germany
FQPA	Food Quality and Protection Act 1996 (USA)
GATT	General Agreement on Tariffs and Trade
HortResearch	Horticulture and Food Research Institute of New Zealand Ltd
HQ	hazard quotient
HSNO	Hazardous Substances and New Organisms (Act 1996)
IDS	integrated defense systems
IPCS	International Programme on Chemical Safety.
IPM	integrated pest management
IUCN	International Union for the Conservation of Nature
IWMCS	Interagency Workgroup on Multiple Chemical Sensitivity
LC50	concentration of a pesticide required to kill 50 percent of a test population
LD50	dose of a pesticide required to kill 50 percent of a test population
LOEL	lowest observed effects level

MAF	Ministry of Agriculture, and variously Fisheries or Forestry depending on date
MCS	multiple chemical sensitivity
MfE	Ministry for the Environment
MoH	Ministry of Health
M-WRC	Manawatu-Wanganui Regional Council
NOAEL	no observed adverse effects level
NOEL	no observed effects level
NRDC	Natural Resources Defence Council
NRC	National Research Council
NAS	National Academy of Science
OECD	Organization for Economic and Cultural Development
PAN NA	Pesticide Action Network North America
P/CCRARM	Presidential/Congressional Commission on Risk Assessment and Risk Management
PCP	pentachlorophenol, an organochlorine wood treatment pesticide
PHC	Public Health Commission Rangapu Hauora Tumatanui.
ppm	parts per million
ppb	parts per billion
PRS	pesticide rating system
RfD	reference dose
RMA	Resource Management Act 1991
SF	slope factor
TEL	tolerable exposure limits
TWPCRASC	Technical Working Party on Carcinogen Risk Assessment for Soil Contaminants
TT-WTWT	Talking Technology—Whiriwhiri Tahi, Whakatau Tahi
US EPA	United States Environmental Protection Agency
US FDA	United States Food and Drug Administration
WHO	World Health Organization

Glossary of Maori words and terms

The definitions given below are those provided by Williams' (1975) Dictionary of the Maori Language, unless otherwise specified, in which case the meaning provided is consistent with the context within which the word or expression was used.

Hapu	sub-tribe
Kaitiakitanga	the exercise of guardianship by the tangata whenua of an area in accordance with tikanga Maori in relation to natural and physical resources; and includes the ethic of stewardship (Resource Management Amendment Act 1997, section 2(4)).
Karakia	a form of spiritual expression (Jarman *et al*. 1996)
Mana	vested with authority, influence or power
Mana putaiao	interpersonal responsibility (Jarman *et al*. 1996)
Mana tangata	personal integrity, described by Jarman *et al*. (1996) as ensuring that "our actions have significance and we do not entertain wanton and callous destruction, or depletion of resources simply because we have a short term 'need'" (p.94).
Mana whenua	having authority over the land
Mauri	life principle
Mauriora	life principle, same as mauri.
Pakeha	person of European descent
Papatuanuku	Earthmother (Jarman *et al.* 1996)
Taonga	highly prized, treasure
Tangata whenua	local people, literally people of the land
Tapu	under a restriction of a religious nature, often referred to as sacred
Tikanga Maori	cultural and spiritual norms; defined by the RMA as meaning Maori customary values and practices
Tino rangatiratanga	an obligation, a duty and a commitment to interact with our world in the most responsible and appropriate way we see fit, in order to fulfil our needs (Jarman *et al*. 1996).
Tipuna	ancestor, same meaning as tupuna
Tupuna Maori	ancestors of the Maori people
Waahi tapu	sacred place
Whakapapa	common descent (Jarman *et al*. 1996)
Whanaungatanga	kinship-like relatedness (Jarman *et al*. 1996)

Introduction

Pesticide policy is normally regarded as policy of a technical nature, revolving around the registration of pesticides and the deliberations of scientific experts. The central purpose of pesticide policy is usually to make available, to those who wish to use them, pesticides that do not cause 'unacceptable risks' to humans and the environment.[1] The finer details of the registration process revolve around the degree of acceptability of harm from pesticides, and how this is balanced against economic benefits, environmental and human health imperatives. The wider pesticide policy may or may not involve tools such as taxes or subsidies. It may require users to be trained in 'safe use'. It may involve a number of other items relating to the keeping of records, the disposal of containers, storage, transport, conditions of manufacture, experimentation, export and import, etc. In a number of countries, particularly in Europe and Scandinavia, pesticide policies contain targets and tools for reducing pesticide use, and the promotion of agricultural techniques that use fewer pesticides. A review of these policies and policy tools can be found in Watts and MacFarlane (1997), and they will not be revisited in this thesis, except where they may be illustrative of a point.

What is of central interest to this thesis, are the silences and gaps in traditional pesticide policy: the silences regarding society's values and the effects of pesticides, and the gaps between toxicological risk assessment and the reality of everyday experience, between what the experts say and what happens in the field. Pesticide policy exists in those silences and gaps. It exists, but is rarely made explicit. It exists as an institutionalized set of values and presumptive rights that are seldom acknowledged and which, it will be argued, do not encompass the worldviews of society as a whole. This, it is contended, is unethical. Wherever pesticides are used, there is the potential for adverse human health and environmental effects. The ignoring of these is, in itself, a policy statement.

Wherever pesticides are used, there is also the potential for social conflict, a conflict between the 'rights' of the users, and the 'rights' of those effected, both human and non-human. The effects may be physical, cultural, or social. Consequently, there is a significant and, it is contended, increasing sector of society that expresses the view that prevailing pesticide policies are not acceptable. Societal conflicts over pesticides are not

[1] The term pesticides is used throughout this thesis in its internationally understood form, and as confirmed by New Zealand law, in particular the Pesticides Act 1979: it includes all insecticides, herbicides, fungicides and other chemicals and compounds used to kill unwanted organisms. The term is *not* used here in the manner in which some people in New Zealand use it, that is to mean only insecticides.

generally characterized by the "mass protest and acrimonious battles" (Bührs & Bartlett 1993, p.52) that were the hallmark of relationships between conservationists and the New Zealand government a decade ago, or that are becoming increasingly common on the streets wherever the World Trade Organization is meeting. In the minds of many the pesticide issue may be characterized by popular books written by outspoken scientists, such as Rachel Carson's *Silent Spring* (1965) and Theo Colborn's *Our Stolen Future* (1996). It is contended that it is, in fact, more accurately characterized as a diffuse and decentralized social movement—the combined efforts over forty to fifty years of many thousands, if not millions, of individuals around the world whose lives have been adversely effected by pesticides, or who have understood the plight of those who have been effected, or the environmental consequences of indiscriminate pesticide use. It includes those who merely wish to buy for their family's table food that does not contain chemical residues, and those who have been made too ill by spray drift to do more than raise a pen in protest. It includes those who are made ill by their daily application of pesticides in the plantations of Asia, and scientists who piece together the disparate bits of evidence about environmental effects. It includes those who bang on the doors of the halls of power in an attempt to turn the politicians' eyes towards the problems. As the years have progressed and the problems remained, this social movement has absorbed the discourses of environmentalism, feminism and globalization, and of other social movements that have come to recognize the root causes of many social problems, identifying some common denominators and setting out to find solutions.

This thesis is one attempt to find a solution to the social, cultural and environmental problems relating to pesticide use. It does not provide a catalogue of adverse effects on humans and the environment, although some illustrative examples are provided. Instead, the focus is on the process by which ethical pesticide policy can be developed and implemented. Again, it pays little attention to policy tools, but concentrates on the four major ingredients of the policy process that, it is contended, must be addressed in an ethical policy process: four elements which are crucial to determining the outcome of a pesticide policy process. These elements are societal values, the attitude towards nature on which the pesticide policy rests, the knowledge that is admitted to the policy process, and who it is that makes the policy decisions.

Societal values

Pesticides are regarded by many policy makers as an issue for scientific consideration, and the weighting of the risk a pesticide poses against its alleged economic benefits. However, this thesis will argue that pesticide policy is, or should be, social policy. It is

about values and whose values should take primacy. It is about risk and, where decisions are to be taken about risks, ethical implications are introduced (Cothern 1996, p.49). Ethics is concerned with decisions about how decisions are going to be made and according to what principles (Cothern 1996, p.49), and that is the purpose of this thesis: unravelling how decisions are currently made, proposing a different ethical basis, and building on that ethic to determine how decisions should be made.

Those who seek to discredit people who speak out about pesticides encapsulate the conflict over pesticides as one between the objective, rational, scientific experts making decisions for the betterment of society, on the one hand, and on the other the fearful, emotive, irrational, and uninformed public. But, as this thesis will show, the public make their assessments about pesticides, commonly dismissed as 'perceptions', on the basis of value systems that differ to those that underlie the scientific assessment of risk. Additionally, it will be shown that the later is not as objective, rational, and 'scientific' as it is made out to be. As Richard Cothern put it, risk assessment is:

> . . . a political debate among different value frameworks, different ways of thinking about moral values, different concepts of society, different attitudes towards technology, and different ideas about risk taking.
>
> Cothern 1996, p.55.

The burden of proof and the standard of proof are matters of ethical concern, not matters of scientific fact (Brown 1996, p.125). So too is the question of who should bear the risks and who should reap the benefits. It is an issue of distributive justice, an ethical choice that has been made, but not made public. Who should shoulder the consequences of spray drift—the victim or the person who caused it? The "moral conditioning of risk assessment", as James Nash (1996, p.196) described it, is not made clear and explicit. One of the tasks of this thesis is to make it clear with respect to pesticides. It will be shown that the public's concerns about pesticides cannot be written off as the result of irrationality, or a lack of knowledge or understanding that can be swept away by improved communication and the earnest pursuit of objective science as the appropriate basis of public policy.

Attitude towards the environment

The 'moral conditioning of risk assessment' is even more insidious in the area of attitude towards nature. All pesticide policy rests on an ethical basis, but that ethic is seldom, if ever, made explicit. Rather, the values of some, the technological enthusiasts, are subsumed into the policy without thought or discourse. The assumption that pesticides

are necessary to modern life, especially agricultural life, is one example. Another is the primacy given to economic issues over social and environmental issues. Pesticide policy is generally based on an anthropocentric approach to the environment, in which the latter is treated as a commodity and in which non-human inhabitants of the ecosystem have no intrinsic rights or value. Utilitarianism is assumed to be rational, as is the assumption that the environment is there for human use. The later assumption has become tempered in some countries in recent years in an attempt to reduce the level of contamination to one that is 'sustainable', but it still rests on the belief in humanity's 'right' to utilize the environment at will. As a result, pesticide policy fails to come to terms with the reality of the interconnectedness of all nature, i.e. ecological rationality, and science's inability to accurately predict the outcome of the continual dispersal of pesticides within the ecosystem on which our lives depend. This thesis will argue for pesticide policy to be based on an ecocentric ethic that involves a partnership approach to non-human nature and a respect for its intrinsic values and rights. It will argue that using pesticides in a manner that enables the management of pests, weeds and diseases in a way that meets the needs of the world for food and fibre, whilst causing minimum harm to humans and the intrinsic interests of non-human nature, is the most ethical and rational approach to pesticide policy.

Knowledge

The third vital element of the pesticide policy process is that of the knowledge that is used to inform the decision-making. Generally, that is scientific knowledge admitted through the risk assessment process. An in-depth analysis of this pivotal information system will reveal the traditional approach of toxicological assessment to be wanting. It is a scientific process that involves very few facts, but a significant amount of mathematical modelling, estimations, assumptions and judgements—all of which stem from, and are influenced by, the value system of those involved.

> [It] suffers from fundamental uncertainties about causal mechanisms for cancer and other hazards, extrapolative relationships between high-dose and low-dose responses and between animal and human risk, latent effects and latency periods, special sensitivities in exposed subpopulations, past and present exposure levels, dispersion patterns of contaminants, and virtually every other area of required knowledge.
>
> Latin 1988, p.304.

Although this comment was written in 1988, not much has changed, except for the uncovering of the possibly profound impacts of exposure to very low doses of endocrine

disrupting pesticides, the policy implications of which will be described in Chapter 6. The problems relating to toxicological risk assessment will be addressed in Chapters 3 and 4. This process will be shown to be incapable of accurately depicting the actual reality of everyday human and non-human exposure to pesticides—that of ongoing low doses of mixtures of chemicals. Additionally, Chapter 4 will discuss the policy implications of multiple chemical sensitivity, still a controversial topic but with significant support in medical writings, and one which cannot be accommodated within toxicological risk assessment. Multiple chemical sensitivity involves the extraordinary sensitivity of some individuals to tiny amounts of pesticides. This medical problem challenges the basic tenet of toxicology, that the dose makes the poison, i.e. that a pesticide only becomes toxic when sufficient amounts are inhaled, ingested or absorbed, those amounts being definable on the basis of effects of high doses on rats in laboratory trials. This tenet is also challenged by scientific findings of inverse-dose responses, i.e. that less of the chemical will cause more of an effect.

Thus, the failings of the toxicological process, traditionally the knowledge system relied upon for pesticide registration decisions, leads to an understanding of the need to incorporate other knowledge into the decision-making process. It will be argued that wisdom is needed, as well as knowledge, and that wisdom can be found in the experiences of effected communities and in the expertise of community and public interest organizations, some of which have carried out very useful social and epidemiological studies of the effects of pesticides. Wisdom is also to be found with those farmers experienced in the management of pests, weeds, and disease without the use of hazardous chemicals. Neither technical experts nor science are banished to the shadow lands long inhabited by societal values and community expertise, but instead take their rightful epistemological place alongside these long neglected sources of wisdom.

The sociology of knowledge becomes an important aspect of pesticide policy once it is understood that risk assessment is not only methodologically flawed, but also value-based. The systems of knowledge that are traditionally accepted into pesticide policy are socially based, and it will be argued that the knowledge admitted should reflect the reality of social needs and experiences, rather than the value systems of one particular culturally constructed epistemology, namely positivist science.

Who should make the decisions?

Thus, risk assessment will be shown to be something other than that which it is purported to be. Frank Fischer, from the Department of Political Science at Rutgers University, asserted that:

> Risk assessment (and risk-benefit analysis) have been government and industry's official response to the fears and anxieties caused by toxic risks. As an effort to refocus debate away from community fears, risk assessment has been introduced to emphasize technical factors and the search for 'acceptable risk'.
>
> Fischer 1993, p.174.

It has not worked: the community was not been persuaded out of its views by scientific risk assessment. Instead, the risk assessment process itself increasingly has become the bone of contention (Fischer 1993, p.175). It has brought to the foreground issues of democracy: Fischer observed that risk assessment is little more than a "technocratic method designed to replace citizen-based democratic processes with exert-dominated policy decisions" (p.175). The general trend across the policy fields has been to diminish effective public input by instituting a risk assessment regime dominated by technical experts, yet hiding its diminished democracy behind public consultation and submission processes.

Thus, the fourth vital element of pesticide policy is that of who should be making the policy decisions, including establishing the initial policy framework, and undertaking the day-to-day translation of that framework into policy and then implementation of that policy. Traditionally, such decisions are the work of bureaucrats. However, this thesis will argue for greater democracy in pesticide policy. It will argue that, because pesticide policy issues are those of values and rights as well as science and economics, there must be broader societal involvement in pesticide policy decisions. It will argue that those who lie in the path of the policy, i.e. those who wish to use pesticides and those that are effected by that use, should be involved in the policy decision-making. It will propose a tripartite approach to decision-making, involving farmers, public interest groups with expertise in pesticides, and bureaucrats. It will exclude the pesticide industry from the decision-making table for ethical reasons that will be discussed in Chapter 7.

Finally, it is important to note that the policy process developed here is developed specifically for New Zealand, a small island nation, heavily dependent on its agricultural system. It is developed for a particular time, that of the beginning of the new millennium, which, it is contended, brings with it a changing consciousness about humanity's relationship with nature. Its findings are therefore context-dependent as, it

will be argued, is all knowledge. However, these findings should be broadly applicable to other countries and even to other policy areas, particularly that of genetic engineering.

> The challenge for modern society is to provide political means for visionary long-term policies together with increased participation by those who are affected by the political decision.
>
> Dienel & Renn 1995, p.119.

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Chapter 1 The Policy Context: Developing Policy to Reflect Society's Values

Introduction

Before embarking upon the development of ethical pesticide policy, it is important to first understand the failings of current approaches and to provide a contextual background upon which such an analysis can rest. Therefore, this chapter will take a theoretical look at the main aspects of the policy process, where appropriate illustrated by aspects of New Zealand pesticide policy, and with occasional reference to the policies of other countries for comparative purposes or where information is lacking. In so doing, it will provide an overview of New Zealand pesticide policy, a policy that resides in silences and is buried within statutes more frequently than it is made explicit. This chapter will begin to draw attention to some of the central themes of this thesis, such as the role of social values in policy and the conflict between these and the instrumental rationality of science-based policy, themes that will be returned to in each chapter. It begins to point to the contradictions between pesticide policy as it is ordinarily conceived and the conflicting requirements of society.

1.1 Public policy

1.1.1 A description

Mark Considine (1994) of the University of Melbourne offered two interpretations of the thing that is 'public policy'. The first was the standard view that "a public policy is an action which employs governmental authority to commit resources in support of a preferred value" (p.3).[1] The second was his alternative view, in which "policy is the continuing work done by groups of policy actors who use available public institutions to articulate and express things they value" (p.4).

The two approaches are very different. The first, the standard approach, Considine described as being instrumental. It turns policy into a theory of choice and a study of costs, avoiding the larger social questions. Peter Berger (1974) would have described it

[1] An example of this standard view is Gerston's (1997) definition of public policy as "the combination of basic decisions, commitments, and actions made by those who hold or affect government positions of authority" (p.5).

as the 'engineering' approach.[2] The second approach is inclusive of a wider range of non-governmental 'actors' and emphasizes societal values, but still recognizes the central role of government authority in sanctioning action.

Commonly, those writing about the policy process assume its outcome to be legislation and the commitment of substantial government resources (e.g. Hogwood & Gunn 1984; Gerston 1997). Yet Considine, in support of his 'alternative' view, described policy as expressing any or all of the following:

- clarifications of public values and intentions;
- commitments of money and services; or
- granting of rights and entitlements.

Considine 1994, p.3.

At the very least, policy making is an attempt to direct human effort and resources. This does not necessitate the passing of legislation, although Considine (1994) did state that "in the public sphere values must ultimately be located within a framework of rights" (p.5). He also observed that policy making is "a continuous process for institutionalising values" (p.52). Those values, and the rights that may or may not frame them, play a central but seldom acknowledged role in pesticide policy and their importance will be emphasized throughout this thesis as a central theme.

It is contended that there is a third approach to public policy: a do-nothing policy, or a do-not-intervene policy. Even where there is no evident policy on a particular issue, there may in fact be a hidden policy. There may or may not have been a deliberate process of deciding to have no explicit policy. This may result from the possibility of such a policy violating other policies that are regarded as superior, or international free-trade agreements such as GATT. At the least, there has been a sub-conscious, or perhaps uninformed, failure to specify such a policy. This contention is supported by Hogwood and Gunn:

> Policy behaviour includes involuntary failures to act and deliberate decisions not to act. Such 'non-decisions' include circumstances in which a person or group, consciously or unconsciously, creates or reinforces barriers to the public airing of policy conflicts.
>
> Hogwood & Gunn 1984, p.21.[3]

[2] Berger, Professor of Sociology at Rutgers University.
[3] Hogwood & Gunn cited three supporting texts: Bacharach & Baratz 1962; Heclo 1972; Lukes 1974.

New Zealand's failure for many years to develop any explicit policy on pesticide use is, at first glance, one such example. It was not until more than fifty years after pesticides were introduced into agriculture that an in-depth investigation into their use was commissioned by the Ministry for the Environment. The ensuing report (MacIntyre, Allison & Penman 1989) contained a number of recommendations, the majority of which were not actioned. Nor has any policy been made explicit since then. There remained only a registration scheme and the Pesticides Act 1979 that set up that registration scheme.[4] The Pesticides Board was empowered by that Act, section 13(1)(a), "generally to promote the prudent, effective, and safe use of pesticides", as well as to register them (section 13(1)(b)). The Board has several other minor functions, but section 13(1)(a) of the Pesticides Act 1979 amounts to the only clear statement of policy on the subject. Thus, whilst there was no overt policy developed to incorporate the many other facets of issues relating to pesticides, the mere existence of the Pesticide Act and its registration scheme did in itself constitute a pesticide policy. That this policy may have been, or have become with time, inadequate is evidenced by the ongoing public concerns about pesticides, some of which were given voice in the 1989 report by MacIntyre *et al*.

This lack of overt policy making should not be interpreted as there being no problems with pesticide use that require rectification—the 1989 report made it quite clear that there were.[5] Rather, it should be interpreted as the government's unwillingness to involve itself in the situation, seemingly for two reasons. Firstly, it has generally shown great reluctance in acknowledging the existence of any problems relating to pesticide usage, no doubt because it has promoted and defended their use for so many years.[6] Secondly, the years following the release of the report have been marked by the ever increasing reluctance of government to regulate industry, preferring instead that agriculture, in this instance, solve its own problems on a voluntary basis.[7] Such a

[4] A number of other minor regulations and statutes impinge to a degree upon pesticide policy, for example the Toxic Substances Act 1979.

[5] The executive summary of the report stated that "the heavy spraying in New Zealand and the overwhelming emphasis on export agriculture appear to take a heavy toll on our health and environment" (MacIntyre *et al*. 1989, p.xii).

[6] For example, in an address to the Agricultural Chemical & Animal Remedies Manufacturers' Association (AGCARM), the Minister of Agriculture emphasized the contribution pesticides can make to sustainable land management, stated that New Zealand does not suffer from over-use, and urged the Manufacturers to develop products to "enhance the contribution of your industry to sustainable land management" (Smith 1996, p.2). In the 1960s the Ministry of Agriculture and Fisheries (MAF) "advised farmers to liberally use [DDT] to control grassgrub" (MacIntyre *et al.* 1989, p.105), and "it was the government and its scientists that assured farmers that it was 'good agricultural practise' to apply DDT-superphosphate" (p.105).

[7] An example of this is the retaining of pesticide applicator training as a voluntary activity of organizations like the Agricultural Education Trust, rather than making training compulsory as has been

voluntary, industry self-regulation approach does not, however, preclude central government policy making: there is still a role for Considine's 'clarification of public values' and 'commitment of money and services', even if the government is shy of the 'granting of rights and entitlements' through legislation or regulation.

Eventually, the New Zealand government did make a policy move that reflected what Considine (1994) regarded as the standard view of public policy: the use of "governmental authority to commit resources in support of a preferred value" (p.3). The government moved to replace the Pesticide Act, and a number of other Acts, with the Hazardous Substances and New Organisms Act 1996 (HSNO Act) and the Agricultural Compounds and Veterinary Medicines Act 1997 (ACVM Act).[8] The passage of these two Acts did explicitly institutionalize a certain set of values as policy statements. For example, the HSNO (Methodology) Order 1998, section 9, requires the Environmental Risk Management Authority (ERMA) to "recognise risks, costs, benefits, and other impacts" in registering pesticides, thus precluding the use of absolute standards, or the principle of minimum harm. Section 24 requires the use of "recognized risk identification, assessment, evaluation, and management techniques" and, as will be shown in Chapters 3 and 5, these 'recognized' processes come complete with particular value systems that will be shown in Chapter 2 to differ from those of the general public. The ACVM Act introduces consideration of export market requirements as a primary purpose of the Act as opposed to, for example, internal food security or organic agriculture.

The HSNO Act also implicitly grants rights and entitlements, such as the right to keep on spraying, and drifting. It does explicitly acknowledge some cultural rights, those of the tangata whenua,[9] and not so explicitly denies others such as those of organic farmers.[10] But, nevertheless, it is an example of Berger's 'engineering' approach to policy with its

done in countries such as Denmark, the Netherlands, Germany, and Ontario in Canada (Fritz, Renouf, Munn, Webb & Wynen 1995; Matteson 1995; FMFAF 1996; Rowland 1996).

[8] Although the HSNO Act was passed in 1996, and that part which relates to new organisms commenced in 1998, by January 2001, that part which relates to pesticides and other hazardous substances had still not become operative, nor has the ACVM Act. Pesticides have continued to be administered under the Pesticide Act 1979.

[9] Tangata whenua means local people, literally the people of the land (Williams 1975).

[10] The denial comes about in the proposed regulations and their failure to protect certified organic properties from spray drift. The Minister for the Environment, writing in support of the proposed regulations, specifically passed this responsibility to regional councils to protect organic farmers if they so wished: "The Resource Management Act allows councils to impose stricter limits for particular locations where this is required by the community. This step could well be considered by councils, for example, in situations where conventional farming and organic farming are being undertaken in adjacent areas" (Upton 1998a, p.3).

emphasis on choices whilst ignoring the larger social questions. Perhaps the most outstanding example of the unquestioned institutionalising of a value that will bias all deliberations made under this Act can be found in the Annotated Methodology (ERMA 1998), which asserted that "[this document] reflects a premise that, while there may be some substances and organisms whose risks are clearly incapable of being satisfactorily managed, and which should not therefore be introduced into New Zealand, with most applications the issue is likely to be establishing conditions for effectively managing the risks" (p.4). This is a clear indication of the intention to register most pesticides for which registration is requested. This is a policy statement, clearly based on a premise that pesticides are desirable. There is no room whatever for consideration of the value that might be placed on organic growing or on human health. There is no room for figuring out whether or not pesticides are actually needed, it is just assumed that they are. The Act thus fails to accommodate wider societal values, just as it also fails to accommodate the range of non-governmental actors affected by it, both aspects of public policy advocated by Considine.[11]

This account illustrates another feature of public policy, and that is that policy formation is not a static event: first it didn't exist, then it was developed, and now it exists *in toto*. Rather, it should be regarded as a "continuing succession of episodes" (Considine 1994, p.7), as it changes constantly in response to the actions and reactions of the various players. Once a policy has been developed and implemented, it then interacts with the various actors involved in a way that will result in endless changes to that policy. This is in part because of changing social, technical and economic conditions, and in part because most policy decisions are made on the basis of inadequate knowledge, reflecting Berger's (1974, p.xiii) 'postulate of ignorance': decision-makers do not have perfect information on which to base a policy, nor perfect knowledge of future courses of events, therefore there can never be absolute certainty about the outcome of a policy. This aspect of public policy as an ongoing event has important implications for the development of ethical policy: as will be discussed in Chapter 7, there needs to be

[11] No representatives of the public or of community groups are involved in the decision-making authority, ERMA, under this legislation. ERMA's predecessor, the Pesticides Board, did have one person representing community organizations by tradition rather than by statute (as the nominee of the Minister for the Environment). This "symbolic reassurance of the public" resulted from concern that the Board prior to the Pesticides Act 1979, the Agricultural Chemicals Board, was regarded as being "pro-agriculture" in its decision-making (MacIntyre *et al.* 1989, p.32). As the community's representative on the Pesticides Board since 1995, the author can attest that the decision-making continued to be pro-chemical, and the removal of that representation under the new regime has not engendered a feeling of inclusiveness as advocated by Considine, despite the provision of a public submission process.

consideration of the decision-makers involved in the initial policy development *and* the ongoing fine-tuning and implementation.

In summary then, there are two distinct types of public policy that can be brought to bear on pesticide issues: that which focuses on government authority and its preferred values, and that which is inclusive of the wider community and accommodates a breadth of social values. In addition, there is the deliberate choice of not bringing any policy at all to bear on the subject which, contrary to appearances, is nevertheless a public policy in its own right. Regardless of the model of policy development that is followed, the policy will continue to evolve with time. It is contended that ethical pesticide policy should be of the second kind—that which is inclusive of the wider community, including non-human nature, and which accommodates a breadth of social values.

1.1.2 Traditional approaches to policy development

The standard view of public policy has been referred to already. This standard view has evolved from the traditional models of policy development, a closer look at which will assist in obtaining an understanding of why traditional approaches are inadequate for pesticide policy. Essentially, this is because they fail to address ethical and normative issues, according to John Forester (1993, p.19).[12] They fail to address the wider societal value systems (Considine 1994, p.3), and it is precisely this failure, as will be demonstrated, that lies at the roots of the conflicts within society over pesticide use. Those value systems, and how current policy fails to address them, will be elaborated upon throughout this thesis, but first a brief examination of the standard policy making approaches.

Traditional models of policy making tend to revolve around the approaches of 'rationality' and 'bounded rationality' ('satisficing') of Herbert Simon (1957, 1983), and the incremental 'science of muddling through' approach of Charles Lindblom (1959), tempered by the middle way approaches of writers such as Amitai Etzioni (1967).

The so-called 'rational' approaches are of the greatest interest with respect to pesticide policy, for it is to these that the most frequent recourse is had. They include, in economics, the concepts of perfect competition, utility and social welfare functions, and cost-benefit analysis, all of which underlie the free-market libertarian philosophy (Hogwood & Gunn 1984, p.44-5). They include, in science, the concept of risk-benefit

[12] Forester, Associate Professor of City and Regional Planning, Cornell University.

analysis. Forester (1993, p.21) described the problem-solving, rationalistic, 'scientific' models as tending to reduce social and political questions of values to seemingly technical matters—what Berger (1975) termed the "engineering mentality" (p.173). Forester (1993) also used the engineering metaphor, describing the problem-solving perspective as beginning with "the engineer's special bias, the rationalism of Descartes' *Discourse on Method*" (p.21).

Simon's approach to 'rational' decision-making was based on identifying all the options and the consequences of these options, and then relating these consequences to a system of values. Lindblom's approach to policy making was to first define the values, next specify the objectives to be achieved compatible with the values, then identify relevant options, and having calculated the consequences of these options, select that which maximizes the values earlier defined. Both these approaches require perfect knowledge of the values and options in order to work properly, i.e. 'rationally' (Hogwood & Gunn 1994, p.45-7). Since perfect knowledge is not feasible, the idea of bounded rationality arose, in which the objective is to 'satisfice' rather than to 'optimize', i.e. to provide expectations than can be satisfied rather than the optimal expectations (Forester 1993, p.6-7), an "invitation to make-do" (p.23).

The main problem with the rationality approaches lies in the area of values. This is the arbitrary element that cannot be determined by a model but must be supplied to it. But by whom? Lindblom (1959) acknowledged that "were he pressed, he would quickly admit that he was ignoring many related values and many possible important consequences of his policies" (p.279). Hogwood and Gunn (1984) asserted that to be "truly rational [the] policy would be based upon the *largest* relevant scale of values and interest" (p.49), by which they meant national as opposed to local interests. Even so, who supplies the values: the bureaucrat who may be influenced by the values he/she knows will win accord with the politicians or Ministry heads, or will be amenable to funding constraints? Or are they supplied by the independent policy analyst who will be influenced by his/her own political and ideological biases and assumptions, or wishful thinking? Or should it be those who will be affected by the policy? In the case of pesticides it can be argued that is everyone in the country. How these values and needs are to be represented in an ethical pesticide policy process is taken up again in Chapter 7.

Another problem with the 'rational' policy approach has been the central assumption that goals can be clearly formulated by policy makers. Indeed, establishing a clear causal link between specified goals and specified means is the intention of the 'rational'

approach to policy (Albaek 1990, p.11; Considine 1994, p.258), just as the causal link defines the 'rational' approach of science. Erik Albaek (1990, p.10), however, maintained that in reality it is often very difficult to know the exact ends of a problem, and hence the appropriate goal. Forester (1993, p.20) also noted this problem with the means-ends models of instrumental rationality. He referred to conflicting ends, conflicting means, and changing values, which again alter both the appropriate ends and means. It may suffice, he noted, for purely technical problems, but cannot address questions of changing values. It is at this level that the so-called rational approach fails for, it is contended, values are of the utmost importance to pesticide policy.

1.1.3 A new approach

Forester (1993) believed that "we have come to think of 'ethical' actions as impractical actions, whatever their content" (p.38), as a result of a tradition of political realism which translates to policy making as bounded rationality and satisficing. In a move away from this tradition, Hogwood and Gunn (1984) proposed a more flexible contingency approach, based on adjusting policy making to circumstances and the issue in hand. Albaek noted, in 1990, that the dominance of the 'rationality' approach had declined, but also noted that it was still "influential" (p.10). Niklas Luhmann was more brutal in his assessment of the situation in 1993 (p.44): "hope in rationality declines as the recognition grows that one does not have the time required to obtain the necessary information" to make purely rational decisions.[13] Albaek's and Luhmann's perspectives may well be academic rather than a comment on actual practice. At the most they may apply to some areas of policy, but there is scant evidence of this decline in 'the hope in rationality', that is instrumental rationality, in the realm of pesticide policy to date, especially in New Zealand. For the view that policy should be based on the instrumental rationality of risk assessment pervades not only pesticide registration as previously mentioned, but also general food and health administrations (e.g. PHC 1995a, 1995b; MoH & MAF 2000). Rather than declining, as suggested by Albaek and Luhmann, this type of policy process appears to be increasingly finding favour in New Zealand. The emphasis continues to be placed on an approach that embraces economic utilitarianism underpinned by the instrumental rationality of science with scant, if any, consideration of the ethical.

Considine (1994) contended that, in order to address adequately today's complex problems where the complexity arises out of "an intersection of material, social and cultural facts" (p.254), an innovative policy approach is required. The innovative approach he defined as "a form of intentional action in which new ideas are socially

[13] Luhmann, Professor Emeritus of Sociology, University of Bielefeld, Federal Republic of Germany.

cultivated and refined into negotiated strategies" (p.255). He characterized the approach as involving:

- a systematic application of human ingenuity and democratic values
- a recognition of the key role of social conflict
- concerted negotiation among those affected
- reorganisation of public and private resources, and
- reconsideration of the values which determine the allocation of those resources.

Considine 1994, p.254.

With the innovative approach, there is a greater emphasis on the continuing generation of knowledge, especially that emanating from the public, and a de-emphasis of the elite intelligence of government policy makers. This emphasis is of considerable importance in ethical pesticide policy and will be addressed fully in Chapter 6.

If there is to be a new approach taken to pesticide policy, stepping away from the strictures of instrumental rationality and including the wider societal values and ethics, then it is necessary to take a closer look, firstly, at the policy system and how it affects the end product and, secondly, at some of the important elements of the process of policy formulation. In so doing, specific attention will be paid to the areas of values and ethics, and the granting of rights and entitlements. For it is imperative that these issues are delineated and addressed openly. To fail to do so will prolong rather than resolve the disputes surrounding pesticides. To fail to do so is unethical.

Berger (1974) commented that "the making of policy ought to steer a course somewhere between *enragé* ideology and 'merely technical' pragmatism" (p.221). This sentiment is echoed by Hogwood and Gunn:

> Success should be defined at a level above that of minimally acceptable performance. On the other hand it is rarely useful to set some ideal standard which is likely to be self-defeating.
>
> Hogwood & Gunn 1984, p.162.

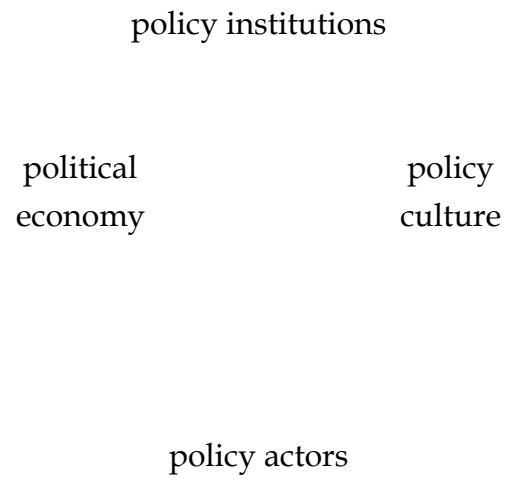
Nevertheless, a case can be made for developing the ideal standard in order that there is a yardstick against which to measure that middle course: if the ideal is not there, how do policy makers know where the shortcomings of the policy under development lie, and how can they make transparent these shortcomings? Indeed how can they achieve improvements if they do not know what they are aiming for? The rest of this chapter will continue to elucidate the policy process as it is, and as it has been. The development

of a new model of pesticide policy processes will begin in Chapter 5 and continue in Chapters 6 and 7, an ethical approach to the policy process that will steer the course of the ideal, rather than the middle as recommended by Berger. The term 'ethical pesticide policy' will occur on occasion: what exactly is meant by this term will be not be fully realized until the conclusion of this thesis. In the meantime, the preceding material will steadily build towards an understanding of what is necessary for a pesticide policy to be ethical.

1.2 The policy system

Mark Considine (1994) provided a useful method of analysing the system within which policy is developed, and his approach will be used here to explore the various aspects of this system and how they affect pesticide policy. His analysis makes use of a 'diamond' to depict the set of relationships involved in a policy system (refer Figure 1.1).

Figure 1.1 The structure of the policy system



Source: Considine 1994, p.9.

In this system, the policy actors and the policy institutions interact with each other in two main dimensions: that of relationships and resources (the political economy), and that of values and ideas (the policy culture), with government authority sanctioning and legitimising actions (Considine 1994, p.9,29). Understanding the dynamics of these two dimensions, which form the backdrop for action by the actors and institutions, is vital to the achievement of a pesticide policy that lays bare its values and its intentions, where judgements are transparent.

In the real world, interaction between the policy actors, institutions, culture and economy means that the outcome of a policy can never be accurately predicted. Complex social, political, economic and environmental relationships will require that there be continuing review and readjustment of a policy in order to ensure it still fits society's purpose and does not produce unintended consequences: it becomes an ongoing social process with no beginning and no end.

1.2.1 Policy actors and policy institutions

Policy makers are traditionally regarded as being the elite of elected politicians and appointed bureaucrats, often influenced by powerful industry lobby groups (Considine 1994, p.5). This approach is exemplified by Gerston (1997), who narrowed the concept even further to that of policy makers being only the elected politicians, with the role of the bureaucracy ideally being that of implementing policy, not making it:

> A problem develops when the policy maker [the legislature] expects the bureaucracy to make policy . . . conflict then moves from an open environment to a closed environment.
>
> Gerston 1997, p.119.

In New Zealand, policy is generally developed by the bureaucrats, interacting with the elected politicians at the initial stages of proposal development and then at the final stages of their agreement to the policy. The currently unfolding process for the development of a national pesticide reduction strategy is illustrative of this: the government agreed to a request by a member of parliament for such a strategy and ordered the Ministry for the Environment (MfE) to develop a proposal. If the governing politicians agree to the proposal, it will then be implemented by MfE. The proposed process is that the policy be developed by the bureaucrats, with the draft version made available to the public for comment, and the final version 'signed-off' by the governing politicians.[14]

However, Considine (1994) again enlarged the policy concept, this time to that of policy makers as 'policy actors', which include "any individual or group able to take action on a public problem or issue" (p.6): political parties, the media, environmental groups, social movements, health lobbyists, and others. Once all the actors have had their say, it is the business of the policy institutions to then "confer legitimacy" (Considine 1994, p.6). The

[14] The content of this illustration is drawn from a number of conversations with Green Party MP Sue Kedgely and researcher Duane Burtt during the period June to October 2000.

institutions are those of the bureaucracy and the politicians in the first instance, but also tribunals and courts through their interpretations of law.

Considine's model of the roles of the policy makers and policy actors does not equate to the current consultative *modus operandi* of the New Zealand government. As illustrated above, there is a trend for the bureaucracy to draft the policy proposal, send it to selected members of the public and non-governmental organisations for comment, then prepare the final draft. The extent to which the consultation is inclusive is open to debate, as is the extent to which the expressed values of those consulted are fairly incorporated into the final policy. There is generally no inclusion of Considine's 'environmental groups, social movements and health lobbyists' in the decision-making process, nor is there any attempt to 'negotiate a consensus', at least in the pesticide policy arena. An example of this is the failure to openly consult with representatives of these groups, or other members of the public, on the development of spray drift policy in the form of regulations under the HSNO ACT 1996. What little consultation did occur, with only two groups, was required to be confidential.[15] The decisions were made entirely by the bureaucracy, reputedly under heavy lobbying by 'industry',[16] and working with an "expert group representing a number of industries" (MfE undated, p.1). No attempt was made at negotiating a consensus with the two public interest groups, let alone with any other environmental or health groups or social movements. The resulting regulation did not reflect the views of the two groups.

1.2.2 The political economy

Considine pointed out that policies do not simple arise afresh out of nothing: they have a history of preceding action and inaction, alliances, deals, and attempts at solutions. The term political economy describes this existing structure of key relationships within which the policy develops, the transactions that bind or divide the policy actors, and the flow of resources. It also describes the two basic mechanisms for distributing goods and services to society: the market system and the non-market principles of "entitlements, rights and standards of due process" (Considine 1994, p.12). Which of these two systems is allowed the dominant role in any policy should depend, in theory, on the extent to which the market can deliver efficiently and the extent to which the market fails to

[15] The two groups concerned were Greenpeace and the Soil & Health Association of NZ Inc. The latter group, acting on an ethical view that this policy should be debated publicly, did not in fact maintain confidentiality (Watts 1998a).
[16] This was the opinion expressed by a MAF official at a Pesticides Board meeting, Wellington, March 4th, 1999.

deliver. In practice, the size and role of non-market input required to ensure the public good often may have more to do with political ideology than with efficiency.

New Zealand's current model of policy development is very strongly an economic one, based on a free-market system and the shrugging off by government of the maximum possible amount of responsibility, that being devolved to the regions, to industry, and to an increasing degree to the individual.[17] The Ministry for the Environment's 2010 Strategy (MfE 1995) strongly, and repeatedly, stated the case for the free market economy, secondarily pointing out that it "will not necessarily deliver on other values and objectives that society may have, such as meeting basic human needs, environmental quality, and access to resources for future generations" (p.7). It is revealing that in each section that discusses the pre-requisites for achieving environmental quality, the economy took precedence: for example, of the four key conditions for achieving "a clean, healthy and unique environment, sustaining nature and people's needs and aspirations" (p.9), the first one was "a competitive enterprise economy" (p.45).

The market

Many of the issues relating to pesticide use cannot be accommodated by the market, and hence a need arises for policies to frame that market. Two major hindrances of market performance will be briefly reviewed here as illustrative of the problem. The first is the failure of the price of pesticides to reflect the externalities of their use, i.e. the cost of adverse effects on human health, the agri-ecosystem, and the wider environment (MacIntyre *et al.* 1989; Bowles & Webster 1995; Agne, Fleischer, Jungbluth & Waibel 1995). The second hindrance to proper market function is the inadequacy of information regarding these externalities for the consumer faced with purchasing food (MacIntyre *et al.* 1989).

It seems that the seminal work on pesticides and externalities was that provided by David Pimentel and colleagues (1991, 1993, 1997).[18] Many, but not all, of these externalities arise from the failure of most of the pesticide applied to reach the target pest: Pimentel (1995) estimated that only 0.1 percent reaches the target, leaving 99.9 percent to effect the wider environment. Pimentel and Greiner (1997) provided

[17] This political philosophy found its voice in the RMA 1991, one of the first pieces of legislation to comprehensively devolve what had previously been regarded as government responsibilities for environmental management to lower tiers of government. At the same time, it enshrined a general duty to "avoid, remedy, or mitigate" adverse effects on the environment (section 17).
[18] Pimentel, Cornell University (NY).

quantitative figures for these costs, itemized in Table 1.1, and compared this with the estimated benefits from pesticide use in the USA. They estimated the cost of pesticides to humans and the environment as being more than US $8.3 billion dollars per annum. These are costs that are not captured by the price of the pesticides and their application, which was calculated to be $6.5 billion. In other words, if the market mechanism was to accurately reflect the price of pesticides and their application, the latter would have to more than double. Even then, it would not include the losses from micro-organisms and invertebrates, nor would it include social and ethical considerations. For example, what is the loss to Maori cultural and spiritual values of the organochlorine contamination of shellfish in the Manukau Harbour (MacIntyre *et al*. 1989, p.78)? What is the cost in social terms of human infertility that may result from pesticide exposure? What are the ethical implications of poisoning seven billion domestic animals, let alone all the wildlife, fish and other non-human elements of the ecosystem? Pimentel and Greiner concluded that if the full environmental and social costs could be measured they would be "significantly greater" (p.71) than the estimate of US $8.3 billion dollars per year.

Table 1.1 Negative externalities of pesticides

Effect	Cost (million US$/year)
public health[1]	933
domestic animals and livestock[2]	31
destruction of beneficial predators, pathogens, parasites[3]	520
pesticide resistance[4]	1,400
bees[5]	320
crop losses[6]	959
water contamination[7]	1,827
fishery losses[8]	56
bird losses[9]	2,100
micro-organisms, invertebrates[10]	?
government funds[11]	200
Total	US $ 8.346 billion

[1] 110,000 poisonings per year, thought to represent 73 percent of actual poisonings, plus 12,000 cases of cancer. Human life valued at $2.2 million dollars by insurance industry.
[2] Includes 7 billion cases of poisoning. Cost is largely loss of livestock products through contaminated meat, milk and eggs.
[3] Estimated as increased crop losses and cost of additional pesticide applications.
[4] Assumed a crop loss of 10 percent. Excluded resistance by insects in livestock and humans.
[5] Honey and wild bees: colony losses, honey, wax and pollination losses, loss of honey.
[6] Suppressed growth, spray drift, residual herbicides, liability insurance, excess residues, residue testing.

[7] Ground and surface waters, including monitoring and clean-up costs.
[8] Based on estimate of 6-14 million fish killed each year, loss of food sources, and residues in fish: caused by erosion of contaminated soils, spray drift, leaching.
[9] From direct poisoning, and loss of food supply and habitat.
[10] Breaking down organic matter, fixing nitrogen, and biochemical recycling of other vital elements.
[11] Annual pollution control.

Source: Pimentel & Greiner 1997.

In 1998 Herman Waibel and Gerd Fleischer made similar estimations for Germany. They used a more limited range of externalities, but nevertheless estimated the negative effects of pesticides to be worth 252 million DM per year, compared with 1,680 million DM for the costs of pesticides, their storage and application.[19] Again, the prices of pesticides, including associated activities, would have to rise significantly if the market is to reflect even these limited costs, which, as with Pimentel and Greiner's figures, excluded any social or cultural considerations.

Economic instruments, such as taxes or levies, can be used to incorporate the estimated cost of externalities into the price of pesticides so that the latter more nearly reflects their true cost, and thus help reduce this aspect of market failure. Taxes on pesticides have been used in Sweden, Norway, Denmark, and several States in the USA, but in attempts to change purchasing behaviour and to raise revenue rather than to reflect externalities (Emmerman 1991; Thonk 1991; Hurst 1992; Rutherford 1995). If this approach were to be taken, it is evident from the work of Pimentel and Greiner (1997) that the tax would need to be very substantial, and vary from pesticide to pesticide, if it were to reflect the real effects of each pesticide.

The second major area in which the market fails is the provision of accurate information to consumers on which they can base their food purchasing decisions. Michael Hogan (1995, p.5) made the point that there should not be too much faith placed in individual consumers to, by themselves, make markets work effectively.[20] As he pointed out, "the power of consumers is diffuse, unlike the concentrated power of most producers and industries" (p.5). It also varies with "their capacity to access and deal with information, their susceptibility to persuasion, their socio-economic situation and whether or not they are young or frail, disabled, sick, illiterate, or don't speak English as a first language" (p.5). This is never truer than in the food market, which is overwhelmed by image

[19] They estimated costs for contamination of drinking water, damage to honey bees, loss of biodiversity caused by herbicides, monitoring of food residues, damage to human health, and costs of government control activities.
[20] Hogan, Director, Public Interest Advocacy Centre, a non-profit legal centre, Sydney, Australia.

makers' portrayals of supermarkets as synonymous with fresh produce, health, fun, and value for money, regardless of consumers actual information needs. Individual consumers are not adequately informed of their choices or of the potential health effects of pesticide residues in food. Their capacity to exercise choice varies enormously with their location: most areas do not have a readily accessible supply of produce grown without pesticides for consumers to purchase. As will be demonstrated in the next chapter, the purchasing decisions of many consumers may be effected by accurate knowledge not only about the residues in the produce but also, for example, about the number of animals that are poisoned each year.

Finally, it is worth noting that the issue of market failure is entangled with that of rights and entitlements, the subject of the next section, particularly when spray drift occurs:

> When the use of private property rights by one individual/group imposes . . . unintended costs . . . on another individual group, without compensation, market failure has occurred.
>
> MacIntyre *et al.* 1989, p.86

Rights and entitlements

Focussing on the role of market forces in policy development, regardless of whether or not they can accurately price goods and services, does not in the least alter the importance of rights and entitlements in Considine's political economy, and hence the policy system. For they exist regardless of whether or not they are acknowledged, and this can best be illustrated by an analysis of the spray drift rights in New Zealand.

Pesticide policies, even where they are explicit, tend to operate in a manner in which legal rights are unclear, resulting in presumptive entitlements or property rights: the presumption is made that those who are already carrying out activities have the 'right' to continue to do so, even if that activity is depriving other people/the environment of their/its so-called 'moral rights'. It is contended that the presumptive right to drift is contrary to the common law approach to property rights, in which "the 'absolute right' of private property has always been subject to qualification where others' rights or the public interest is adversely affected by an individual's use of land" (Grinlinton 1995, p.154). This common law approach includes "rights to sue in trespass for intrusions into the airspace or sub-surface beneath an individual's land" (Grinlinton 1995, p.155). As will be shown below, the requirement by existing legislation of proving a causal link between the drift and adverse effects, effectively prevents the operation of the common law approach, resulting instead in a presumptive right to drift. Not surprisingly, then, the former Minister for the Environment Simon Upton interpreted the community's

desire to outlaw pesticide 'trespass' as "the ultimate extension of a property-rights based approach to dealing with a nuisance" (Upton 1998b, p.3).

With the spraying of pesticides in New Zealand, the presumptive right has operated as long as the drift does not cause identifiable and demonstrably causally-linked harm. The Pesticide Act 1979 silently confirms those presumptive rights by outlawing only the drift of herbicides that result in crop loss *and* which were the result of *reckless* application. There is no regulation against drift of insecticides or fungicides, nor against herbicides causing damage other than that to crops. As a result of this, and the need to prove negligence, only one case against spray drift has ever succeeded under this law.[21] Damage to human health could potentially be pursued under other legislation, such as the Health and Safety in Employment Act 1992, which imposes a duty on an employer to ensure that no action or inaction of an employee harms any other person (section 15). Again, the harm needs to be proven for the action to succeed. No statute provides for an offence to have occurred by the mere fact of spray having drifted. The Health Act 1956 does allow for an offence of nuisance if the drift was "unnecessarily offensive or likely to be injurious to health" (section 29(l)). The RMA also silently supports the presumptive rights of drifters by way of confirming the rights of existing land use (section 10). There is a tendency for this right to be interpreted as being the right to continue spraying even if that spray drifts on to other properties, as long as it falls short of a nuisance such as may be an offence under the Health Act 1956, for example.[22]

Agricultural economist Daniel Bromley (1992, p.6) defined entitlements as "the constellation of rights and duties that defines the legal position of parties to any particular conflict" (p.6). He further defined rights in terms of its legal meaning only: "a right is the capacity to call upon the state to protect one's interests in a particular outcome or situation" (p.6).[23] He did not acknowledge 'moral rights' or natural rights, as espoused by English political theorists Thomas Hobbes and John Locke in the seventeenth century. Bromley (1992) claimed that there is no right until it is determined by the legislation or by the courts: "a right only exists when there is a system to insure that the right holder is protected from the claims of another" (p.6-7). On the face of it

[21] *Attorney General v Geothermal Produce NZ Ltd* 1987 2 NZLR (p.348).
[22] See, for example, *RJ McQueen & Ors v The Waikato District & Waikato Outdoor Society* PT A45/94: "we hold that the wishes of orchardists in the vicinity to spray their crops would in law be restricted by the presence of people on the applicant's [neighbouring] property for recreation". *Also ISJ Balle v Franklin District Council* PT A116/93.
[23] Jacobs (1997) defined entitlement rights as "those equal rights that all citizens have to the benefits and burdens of their shared social life" (p.62). Note that she defined rights to include those other than defined by the legal system.

then, there is no right of spray users to drift, and there is no right of the neighbour not to be drifted upon. However the legislation does provide a *de facto* right to the drifter, by protecting him/her from prosecution because of the impossibility of providing causal proof of damage to health: the drifter is implicitly afforded state protection by the nature of the legislation promulgated. The Pesticides Act, the RMA, and the Health and Safety in Employment Act all require that the neighbour prove they have been harmed by that drift, and therefore supports the existence of such drift if the proof cannot be obtained. This adverse effects regime has been reinforced by Regional Air Plans developed under the RMA 1991: for example the Manawatu-Wanganui Regional Air Plan permits the spraying of pesticides as long as "there is no agricultural chemical spray drift *resulting in adverse effects* beyond the target property boundary" [emphasis added] (M-WRC 1998, p.46). The support for continued drifting of spray, as long as there are no provable adverse effects, stems from the twin beliefs that it is not possible to apply pesticides without there being cross-boundary drift, and that it is not possible to undertake agriculture without applying pesticides. Therefore, it is presumed that the primary right should belong to users of pesticides because they have a perceived economic need, as opposed to the neighbours and the wider environment, whose needs may or may not be economic, and therefore are of secondary importance. This is reflected in the *McQueen* decision reported in footnote 22.

The problem with the adverse effects regime lies in two areas:

i. the near impossibility of causally linking health effects to spray drift incidents: for example, Northland Medical Officer of Health, Dr Jonathan Jarman (1995a) stated, with respect to the Newman incident, that "my personal feeling is that some of the illness experienced at Waiotira was caused by the spray but there is no way to prove this" (p.1);[24]

ii. the failure to recognize potential environmental effects of pesticide drift, such as loss of biodiversity.

The failure to resolve these problems leads to the reframing of the argument as one of perceived risk versus actual risk, in which toxicology is wheeled out to undermine the

[24] Laurie Newman, a Northland farmer, was the recipient of a significant dose of 2,-4-D drift from aerial spraying operations over neighbouring farms. He and his family became ill, as did other members of the community (Jarman 1995b), and pine trees and fruit trees on the Newman property were also effected (Dinsdale 1995). Newman has since been diagnosed as having parkinsonism and, in the opinion of the doctor, it appears to have originated with the 2,4-D exposure (Donohoe 2000, p.15). In a telephone conversation on October 2, 2000, Newman asserted that his property has continued to be drifted with 2,4-D from aerial spraying of neighbourhood farms on average at least three times per year.

position of those without current entitlements. Simplistically, the argument that is presented is that if the laboratory rats did not die or get cancer from high dose exposure, it is not possible for humans to suffer ill effects from low dose exposure.[25] This argument is backed up by the economic argument of the need to maintain financial viability, without proving that the spray drift is a necessary prerequisite of that viability, and by the charge that altering the entitlement situation is government interference whereas allowing it to remain as presumed is seen as voluntary industry management of the situation.

Bromley (1992) argued that all rights flow from the state: it is the collective will that bestows rights and duties, and "property rights are the product of civil society making conscious choices" (1992, p.9). This argument might be theoretically correct but, as will be demonstrated with respect to spray drift, it is not necessarily what occurs in practice. As mentioned previously, Bromley also maintained that "natural rights, so fundamental to Locke, form no logical foundation for rights in general, and property rights in particular" (p.8). Yet is that how society believes the situation to be? Do people think that they have a 'right' not to be drifted upon? Is there not a profound difference between the logic of the situation as put forward by Bromley, and indeed endorsed by the legal system, and the situation as perceived by society? If society were asked the direct question: do users of pesticides have the right to drift upon their neighbour, or do the neighbours have the right not to be drifted upon, then most likely the majority would answer in favour of the latter.[26] Yet neither the law nor any pesticide policy has reflected this attitude, and so the pesticide user has had the presumptive rights effectively sanctioned. Many people in society may be more inclined to view their rights in the Kantian way: in terms of ethics rather than jurisprudence. Kant's definition of the universal Law of Rights is:

> Act externally in such a manner that the free exercise of thy Will may be able to co-exist with the Freedom of all others.
>
> Kant 1796, p.181.

Ethics, he maintained, "as distinguished from Jurisprudence, imposes upon me the obligation to make the fulfilment of Right a *maxim* of my conduct" (p.181). Kant's distinction between ethics and jurisprudence is echoed by political philosopher Lesley Jacobs (1997, p.53,65), who differentiated between moral rights and legal or constitutional rights, the former existing independently of a particular legal system.

[25] This argument will be examined in detail in Chapters 3 and 4.

[26] In fact, the New Zealand public did answer in precisely this manner when confronted with a proposal to legalize spray drift at certain levels (Watts 1998b).

It is contended that the right attaching to spray drift is *not* a conscious choice of *civil society,* but rather a choice of those elements of society that hold power. The right to drift pesticides has been upheld by the ruling powers through their failure to alter that presumptive right. This has placed an onus of duty upon those elements of society that are conscious of the problem and possible solutions, and/or personally affected. There has been, and continues to be, a protracted debate during which the presumed right of the drifters remains paramount. These rights attached to the drifting of spray have been challenged by the drafting, and promotion to the parliamentary ballot system, of the Agricultural Chemical Trespass Bill. The Bill states quite plainly that the rights should be reversed: that the neighbour should have the legally sanctioned right NOT to be drifted upon and that the user of a spray should have the responsibility for ensuring that this does not happen—in other words that the Kantian ethical right should become a legal right. The government, in an apparent reaction to this community initiative, devised a regulation under the HSNO Act 1996 that cemented the status quo rights, to a degree. The proposed regulation will permit users to drift spray beyond the boundaries of the property to which the pesticide is applied, as long as that drift falls below a scientifically derived maximum legal level, the Tolerable Exposure Limit, or the pesticide is applied in a manner that is consistent with an approved (by ERMA) Code of Practice. This means that the presumed rights of drifters will be enshrined in law, and this has occurred despite the majority of correspondence on the subject, both to the media and to government ministers, being strongly opposed to the regulation. The former Minister for the Environment noted this strong opposition from the public, and responded: "it's not simply a story of the majority view ruling" (Upton 1998b, p.2). Episodes such as this tend to undermine Bromley's (1992) assertion that it is the collective will that bestows rights and duties. It becomes apparent that it is the will of the legislature that bestows those rights under the traditional approach to policy making, regardless of the will of civil society. In this case, it was the will of the neo-liberalist politicians that the economic imperative should dominate other social imperatives. Bromley (1992) expressed the view that "public policy remains concerned with the welfare of the collective" (p.18). The extent to which that is true must surely depend upon the philosophy of those who hold the political power: if that philosophy holds the short-term economic wellbeing of the individual to be of paramount importance, then the welfare of the collective, including future generations, is unlikely to be the central concern of the policy. Bromley (1992) also asserted that "one can expect to see institutional setups that err on the side of caution when ecological and health effects are probabilistic" (p.18). Perhaps that depends on who is defining the probabilities: the risk managers employed under a free-market non-interventionist regime, or the person

without entitlements. The differences between these two types of assessments will become evident in Chapters 2 and 3.

In summary, then, pesticide policy can either confirm the status quo entitlement regime, always the outcome of an absence of policy or a do-nothing policy, or alter the status quo to favour other parties. In either case, the policy makers should be fully cognisant of the effects of status quo entitlements. Policies that leave it to the market, or rely on voluntary efforts by involved parties, are just as much forms of 'government intervention' through support for the status quo, as those policies that seek to change the status quo entitlements. However, as Bromley (1992) astutely remarked, "if politicians perceive an implicit entitlement structure in which individuals are thought to have a right to something, we should not be surprised to observe actions that display scant interest in taking chances with that perceived right" (p.18). Especially, it is contended, if those perceived rights 'belong' to a traditionally powerful minority lobby group such as Federated Farmers. The challenge, then, for an ethical pesticide policy is to openly acknowledge the situation of presumptive property rights, ascertain what it is that society wants, clearly spell out what those rights will be, then develop a programme for ensuring that they are maintained.

1.2.3 The policy culture

The development of public policy is a "value-laden activity" (Forester 1993, p.15) that carries consequences for all of society. It involves implicit and explicit judgements, and is constrained by the perceptions, values, knowledge and pet theories of those who develop it. The term 'policy culture' describes these unstated values, preferences, assumptions and habits, which underlie the activities that take place within the policy system. Understanding these is crucial to achieving a policy that fulfils its promise.

Values may be made explicit in legislation such as, theoretically, in section 4 of the HSNO Act: "The purpose of this Act is to protect the environment, and the health and safety of people and communities, by preventing or managing the adverse effects of hazardous substances and new organisms". The apparent values are those of environmental protection and human health and safety. But values may also be unstated because there is an assumption that they are common to all actors, or as a means of avoiding controversy: it is contended that the actual purpose of HSNO is not the protection of the environment and the health of the community, but rather the approval for use of hazardous substances and new organisms, thus the primary values relate to facilitating chemical and genetic technology. Pesticide manufacturers never

state that their value system is corporate profit. Instead they couch their promotion of pesticides, and biotechnology, in terms of benefits for farmers and the World's poor. Values underlie various actors' assertions of need such as the need to spray pesticides, or claims of right such as the right to breathe uncontaminated air. Values may lie "buried in the silences" (Considine 1994, p.49) of policy developers, as in the initial proposal to develop a risk reduction strategy for pesticides in New Zealand (Neild 1997, p.8): the proposal suggested promoting integrated pest management as a means of reducing risk, but was silent on the role of organic growing. In this instance, the developers of the proposal had asserted a bias against organic agriculture, never explicitly stating so or explaining why they had done this. Was this bias based on personal values, political expediency, scientific evidence that organic agriculture/biological production doesn't reduce risk, or economic evidence that it isn't financially viable? The following scientific and economic data, then available and current, would suggest that it had arisen from either personal values or political expediency:

i. Analysis of conventional, integrated and biological pipfruit growing systems, based on the pesticide rating system (PRS) developed by the Horticulture and Food Research Institute of New Zealand Ltd (HortResearch) showed that risks from pesticides were greatest for conventional systems and least for biological systems:

Production system	Season	Mean PRS score
Conventional	1994-95	414
Integrated	1996-97	268
Biological	1994-95	133

Source: Walker, Hodson, Batchelor, Manktelow & Tomkins 1997.

ii. Analysis of the same systems based on a number of indicators of sustainability, such as reduction in use of broad-spectrum chemicals and maintenance of profitability, revealed that both the integrated and biological systems showed major improvements over conventional production systems (Wearing 1997).

iii. Additionally, the 'biological' fruit achieved substantial premiums, up to $10/case, over the integrated and conventional produce (Clearwater 1997).[27]

Hence, there was scientific and economic evidence available that revealed organics to be a viable, in fact superior, policy option, noting that 'sound science' and economics are the

[27] Personal communication, Dr John Clearwater, Clearwater Research and Consulting, Auckland; November 1997.

prime values currently underpinning policy development in New Zealand. That it was not included at all can only be explained as a policy action reflecting personal/bureaucratic values and/or political expediency, for omissions of action are equivalent to actions.

Values, particularly those that are assumed and hence seldom expressed, play a paramount part in determining pesticide policy. They will, therefore, be highlighted throughout this thesis, particularly with respect to assessment of risk from pesticides, both by the technical experts and by the public. The particular New Zealand policy culture will be further discussed later, in section 1.4. of this chapter.

Language

The language of policy making is an important aspect of policy culture, for it can frame the underlying values, consciously or unconsciously. Jargon is developed and slips into common usage, but its meaning is rarely explained or defined. It can be used consciously or unconsciously to confuse, to obfuscate and to mollify. Considine (1994, p.15) described such use of jargon as "provid[ing] reassurance . . . a kind of safe haven for those . . . whose work imposes risks and doubts". Jargon can also be used to conceal a lack of meaning.

Policy language can be used to divert attention away from risky areas and concentrate it on safer ones. Considine (1994) noted that "special languages therefore abound whenever critical facts are uncertain, but where their personal significance is high" (p.15), particularly where there is an emotive content involved. The military are especially good at this, as Considine (1994, p.15-6) pointed out, with their reference to bombing raids as 'surgical strikes' and to the deaths of innocent people as 'collateral damage'. The use of the term agricultural compounds, in the ACVM Act 1997, to replace the more commonly used term pesticides is another example. Pesticide issues have long been the subject of community unhappiness and thus there is a degree of sensitivity to the term, but rather than address the cause of the unhappiness policy language has been used in an attempt to sanitize. The sanitization has unfortunately been taken to ludicrous lengths with the vertebrate poison 1080, used to kill possums and rabbits, now being defined by that Act as a veterinary medicine.[28]

Considine (1994) referred also to policy makers' "repertoire of preferred judgements and responses" . . . [that] "combine fact and fiction in order to produce shortcuts for decision-

[28] A veterinary medicine is defined by the ACVM Act 1997 as "any substance, mixture of substances, or biological compound used or intended for use in the direct management of an animal".

making which those in authority will accept" (p.16). He illustrated this with the example of the tendency for the soft-tissue complaints of women employees to be viewed as psychosomatic. In this vein, the term "chemophobe" to describe those opposed to pesticide use can be seen as a piece of jargon that not so subtly undermines their position.[29] The description of chemically-sensitive people as people who "perceive" that they have health problems, at once distances the policy makers from any acceptance of a health problem and therefore any need to address it. Whilst media commentators in a high profile child cancer case referred to 'cures' by chemotherapy, they referred to 'perceived cures' by natural therapies.[30] Such use of language at once acts to undermine the integrity of that which is at odds with the value system of the policy maker, or media commentator, and hence to perpetuate their own values and judgements.

Perhaps the most striking example of the use of loaded terminology, in a manner that discriminates against less powerful interest groups, occurs in the area of risk assessment. Here the powerful role played by language in shaping attitudes has been exploited fully in undermining the validity of the concerns of the public. In this instance, it has been achieved by referring to their *perceptions* of risk in contrast to the scientists' *analysis* of risk, inferring that the former have less accuracy or validity than the latter. The traditional terminology, that of *expert assessment* characterized as analytical, rational, and pertaining to real risk, and that of *public perception* characterized as emotional, irrational, subjective (Slovic 1997, p.60), is heavily value-laden and generates and perpetuates a bias against the public. Ruth Weiner's (1993) comments on the subject epitomize this: she referred to "this separation of *reality* and perception" [emphasis added] (p.495).[31] Yet Chapter 3 will demonstrate that the technical risk assessment of pesticides does not arrive at true facts, at reality, but rather only at estimates. It will also demonstrate the subjective, value-laden nature of the toxicological risk assessment process, well disguised to the average eye by the use of technical language and mathematical models.

Mary Douglas (1985) blamed the emphasis on the public's "perceptual pathology" on a failure to link cultural analysis with cognitive science, with the result that "irrationality

[29] Freudenburg (1992, p.29) supplied the following terms that are also used to describe members of the public whose assessment of risk differs from that of the technical experts: ignorant, selfish, ill-informed, parochial, Luddite, even Communist.
[30] This refers to the episode in February 1999 in which a small child, Liam Williams-Holloway, was made a ward of the state in order that doctors could enforce chemotherapy when the parents had sort natural methods of healing. The terms were repeatedly used on TV1's "Holmes Show" over the period February 11-15.
[31] Weiner, Western Washington University, Washington, USA.

tends to be invoked to protect the too narrow definition of rationality" (p.3). Paul Slovic attempted to improve the situation by referring to the public 'perception' of risks as "intuitive risk judgement" (Slovic 1987, p.280) and, with other writers, as "intuitive toxicology" (Kraus, Malmfors & Slovic 1992; Slovic, Malmfors, Krewski, Mertz, Neil & Bartlett 1995).[32] The discussion in this thesis, of the reasons for the differences in the way risk is viewed by the expert and by the public, will reveal that the latter is as valid as the former and indeed may be as 'expert' as the experts', given differing systems of reference, or rationalities, and experience. Therefore, in order to reduce the unwarranted bias, the terms *technical assessment* and *lay assessment* will be used instead of the more common *expert assessment* and *public perception*, acknowledging that the word 'lay' still carries some negative connotation when compared with the word 'technical', and that some members of the laity are quite capable of technical assessment. Ray Kemp (1993) used the terms 'public assessment' and 'technical-scientific assessment'.[33] It is contended that the use of the word public in this manner would tend to infer an agreed public opinion when this is not usually the case. Perhaps the term 'secular', meaning "not bound by a religious rule" according to the Oxford Dictionary (Brown 1993, p.2753), might be a more appropriate terminology to differentiate the public from the technologist or scientist, noting that the *art* form of risk assessment has become elevated almost to the status of *demigod* in the name of science. Luhmann (1993), also noting the religious element, saw risk calculation as "the secular counterpart of a repentance-minimization programme" (p.11) of the Catholic confessional. Returning to a more secular basis, the two types of assessment could equally be differentiated as 'institutional assessment' and 'human assessment'. The last two suggestions might provide an appropriate reversal of bias. However, in the interests of the minimisation of bias, the terms technical assessment and lay assessment will be used henceforth.

Naming

Hidden agendas, values, and judgements also underlie the way in which a policy issue is shaped and named, and such naming creates boundaries for the problem and for any solutions that might be proposed. For example, allocating pesticide policy to the Ministry for the Environment, or an Environmental Protection Agency, implies recognition of adverse environmental effects that need to be mitigated. However, allocating policy development to the Ministry of Agriculture removes any implication of

[32] Slovic, President of Decision Research in Eugene, Oregon, and Professor of Psychology, University of Oregon, USA.
[33] Kemp, Dames & Moore International Environmental Management Group, Twickenham, UK.

effects on the environment, and instead emphasizes the role of pesticides in agriculture. Naming an incipient pesticide policy as a risk reduction policy clearly states a boundary on solutions: that the solution will not focus on reduction of use of pesticides, as did the Swedish programme for example, but rather on the more amorphous reduction of risk attached to the use of pesticides.[34] Indeed, it also states that pesticides are necessary and will continue to be used and this issue is not up for discussion. Such naming serves not only to announce preferences but also to shut out other options. This issue will be further explored under section 1.3.2, on shaping a policy.

Policy language also exerts an important influence through the naming of goals in a policy. Albaek (1990) noted that they may be "deliberately formulated vaguely in order to cover up a lack of consensus among policy makers", and that "formal, manifest goals may not correspond to policy makers' implicit latent goals" (p.11): in short the stated goals may not be the real goals. The earlier development of the proposal for a New Zealand pesticide policy is an interesting illustration of this: whilst MAF Policy had begun a process of consulting on a *National Risk Reduction Strategy for Agricultural and Veterinary Compounds* (Neild 1997), MAF's Chief Agricultural Compounds Officer (CACO) was reporting to the Pesticide and Animal Remedies Boards' Policy Subcommittees on a *National Strategy for the Sustainable Use of Agricultural and Veterinary Compounds* (Knox 1997). When questioned by the author as to whether or not these were the same strategies, the CACO's response was that 'they' must have changed the name. The question needs to be asked: did 'they' also change their goal or objective, for risk reduction and sustainable use are not the same thing. Indeed they afford quite different perceptions of what MAF might have been trying to achieve. A subsequent third title for the same proposed policy was *National Strategy for the Management of Agricultural and Veterinary Compounds* (Butcher 1998)—yet another variation of the apparent objectives.

1.3 The policy process—some aspects

In developing an appropriate policy there are a number of key questions to which answers are required. These include:

1. What exactly is the issue? How to shape and define it?
2. What is the current situation?

[34] In 1986 Sweden embarked on a programme to reduce the use of pesticides in agriculture by 50 percent, and then in 1990 embarked on a second 50 percent reduction, an overall target of 75 percent reduction (Pettersson 1997). By the end of 1995 the reduction achieved was 71 percent (Anonymous 1996).

3. What has taken place previously?
4. What is known of the impacts of previous actions?
5. What is the objective?
6. How is the objective to be achieved?
7. How is success to be determined? Can this be assisted, for example, by the use of quantifiable performance indicators?

It is not the intention to canvas all of these questions here, merely to note their importance. Some of them will appear again, particularly questions 5 and 6 in Chapter 5 where the development of ethical pesticide policy commences. Questions 2, 3 and 4 have been addressed to a certain extent in this chapter, and will continue as a theme running throughout the thesis. The remainder of this section will elaborate on the process by which an issue is identified in the first instance and then shaped in the second, the first of the questions listed. This will be followed by a brief comment on question 6, implementation.

There are other important aspects of the policy process that are not included in this analysis. This is not to say that they are not of importance, but it is simply that they lie outside of the main thrust of this thesis, which is to illuminate the role of values in determining pesticide policy and the process by which it is arrived at. However, one such area will be briefly mentioned here for it, too, is plagued by value assumptions and judgements. That is the process of forecasting, of assessing, as best as possible, the likely outcomes of the policy, attempting to assess the implications should it be implemented. This may involve a one-off assessment at the beginning of the process, or continuous updating and feedback so that the policy can respond to changing situations. There are a variety of so-called judgmental techniques and modelling techniques available to assist this process. Many of the latter, such as econometric and system dynamic approaches, rely so heavily on assumptions relating to defined variables, that they may not in fact reflect the real situation with any great accuracy. Such assumptions should be made transparent.

1.3.1 Getting the issue on the policy agenda

The very first step in a public policy process is gaining recognition of the need for a policy or policy change for the particular issue. Rochefort and Cobb (1993) argued that there is not necessarily any relationship between the seriousness of an issue and its propulsion on to the policy agenda. In fact, they claim the impact of "the intersubjective nature of social experience" on issue initiation to be "arguably the most fundamental

source of 'nonrational' political phenomena" (p.250). Note their assumption of what is rational and nonrational, indicating the involvement of their own underlying value system. The Oxford Dictionary defines rational as "of, pertaining to, or based on reason or reasoning" (Brown 1993, p.2482). Rationalism is defined as "the theory that reason rather than sense-experience is the foundation of certainty in knowledge" (p.2482). Its opposite is empiricism, which is defined as "based or acting on observation or experiment, not theory; regarding sense-data as valid information" (p.809). In other words, Rochefort and Cobb (1993) appear to be claiming that that which is observed to occur is of less seriousness than that which is 'reasoned' to occur. As will be demonstrated, this has been the traditional approach to pesticide policy and is one of the underlying reasons for its failure to accommodate societal views and experiences.

Gerston (1997) analysed the various triggering mechanisms for a public policy process. Frequently these are what might be termed 'sociological shifts'. They include the government as it sees fit to respond to some problem in society, or to assert its values in the ordering of society—user-pays, privatisation, and regionalism are examples of the latter. Or it may be initiated by the Courts through their interpretation of law. The process may be triggered by the bureaucracy, or it may be triggered by society itself identifying a situation that it does not like and demanding change—the latter mechanism in particular demonstrates the type of "power" that Forester (1993) referred to as "the ability to shape others' attention" (p.6). The trigger may be a groundswell of public opinion or a single dramatic event occurring domestically or overseas. In the former situation, there needs to be a large number of individuals who experience a widely shared problem, sufficient numbers who experience the problem with sufficient intensity to overcome the normal inertia of society to change, in order that a policy response is triggered. Technological innovation may be another triggering mechanism, and an example of this is the relatively sudden advent of genetic engineering in the food production systems of the world. Lastly, ecological factors, such as loss of biodiversity and accumulating groundwater pollution, have played an important role in triggering pesticide policy development in a number of countries, particularly in Europe (Hurst 1992).

Hogwood and Gunn (1984) provided a slightly different analysis of issue triggers. Their list of circumstances that may propel an issue on to the political agenda is as follows:

- the issue reaches crisis proportions, or is perceived as threatening to in the future;
- it achieves particularity, e.g. acid rain exemplifying wide industrial pollution;
- it has an emotive aspect;

- it seems likely to have wide impact;
- it "raises questions about *power* and *legitimacy* in society" (p.68);
- the issue is fashionable in some way.

An issue does not necessarily have to be a problem: it may in fact be an opportunity for positive action, or a trend that is perceived to provide potential opportunities in the future (Hogwood & Gunn 1984, p.108). Such a situation exists with pesticide policy in New Zealand: there exists an opportunity to better New Zealand's situation in the market place, both by being seen to be proactive in this area and by providing real improvements in environmental sustainability, food safety, and public health—especially through organic agriculture.

Triggering the pesticide issue in New Zealand

Almost all of these elements can be seen to have been operative in the 1998 proposal by MAF to pursue the development of a pesticide policy in New Zealand (Neild 1997). The foreign trigger is very pertinent, not as a single dramatic event, but rather through the groundswell of foreign public attitudes resulting in a societal shift overseas (Bührs & Bartlett 1993, p.168). This attitude translated to a requirement by UK supermarkets for evidence of environmental improvement in the production processes of the produce they purchase. Since New Zealand's economy is still geared to export markets for primary produce, and the UK supermarket Tesco is the single largest customer of New Zealand agriculture (Ball 1997), significant attention is paid to such requirements. The response by industry was the development of an integrated fruit production programme for apples (Batchelor, Walker, Manktelow, Park & Johnson 1997). The proposal to develop a pesticide risk reduction policy may well have been the government's response.

Adverse ecological effects of pesticides may be of greater impact in a long-term framework, but they are effects that are generally invisible to the public and hence have aroused little intensity of response in New Zealand. They have therefore, to a degree, been ignorable by policy makers, at least relative to vanishing export markets, so much so that there is no official recognition of a link between diminishing biodiversity and pesticide use in New Zealand. In the massive report on the state of the environment in New Zealand (Taylor, Smith, Cochrane, Stephenson, Gibbs, Saunders, Swain & Wall 1997), the lengthy chapter noting New Zealand's diminishing biodiversity does not specifically identify pesticides as one of the actual or even possible causes. Yet there is sufficient significant overseas research (Stolton 1997) establishing such links to indicate the probability of a similar relationship in New Zealand.

Social evolution cannot be ignored with respect to factors that can trigger pesticide policy development. The Laurie Newman spray drift incident described in footnote 24 was, it is contended, one of the precipitating factors in the development, first of a national spray drift advisory group, and then of the proposal for a national pesticide risk reduction strategy. This incident, dramatic as it was, was nevertheless probably no worse than those experienced by other farmers over the decades since aerial spraying of pesticides commenced in New Zealand.[35] However, the incident occurred at a point in time at which enough people in the community had reached the conclusion that spray drift was not socially acceptable for a policy response to be triggered.[36] That societal shift in attitude had been building slowly for a number of years, but the policy response did not occur until sufficient pressure was exerted by media portrayals of wider problems. The response by one sector of society, a coalition of more than 30 community and environmental groups called the Chemical Trespass Coalition, was to devise and promote proposed legislation to make the users of pesticides responsible for their actions, a dramatic shift from the prevailing attitude of the sprayers rights to drift (Watts & Reeves 1996; Reeves, Watts & Martin 1996).

Whether that shift in society's attitudes will be translated into legislation depends on the government's values and their willingness to acknowledge that evolution in societal attitude. Approximately one year after these events occurred, the government commenced a process of pesticide policy development. However, the bureaucratic response was probably based only partly on a desire to reflect a shift in attitude. It probably had more to do with a fear of the potentially restrictive nature of the proposed anti-drift legislation, that fear being sufficient to galvanize the bureaucracy into action in the hopes of undermining it. Significantly, once the threat of the community's proposed legislation had subsided due to the drafting of regulations that pre-empted and undermined it, the proposal for a pesticide risk reduction strategy faded into oblivion, gathering dust on the shelves at MAF. It reappeared in a different guise, in 2000, as Green Party MP Sue Kedgely's members bill, the Pesticides Risk Reduction Bill, and subsequently as a proposal developed by the Ministry for the Environment for a National Pesticide Reduction Programme.

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[35] For example, Waimana dairy farmer Ian Kinvig was reported in the media as suffering serious disability and pain from 2,4-D drift, which left him unable to milk his cows or drive his vehicle. He was reported as being restricted to walking with crutches, suffering weight loss, insomnia, back and leg pain. Acute effects were reported to include vomiting of blood, fever and stomach cramps. He was admitted to the intensive unit of Whakatane hospital soon after the incident, where "the doctor diagnosed 2,4-D poisoning" (Fifield 1998, p.1).

[36] That Newman profiled his situation through the media with dogged determination would also have played a role in triggering the policy response.

Figure 1.2 Schemata of pesticide policy development in NZ

external pressure	UK supermarkets			
internal pressures	public groundswell (interest groups)	legislative proposal	bureaucratic response	public policy
	Newman incident	media		

1.3.2 Shaping the issue

Once the issue has been triggered onto the policy agenda, it then needs to be shaped and defined. Defining the issue, i.e. giving it boundaries and names, is a highly political rather than a merely technical process, as much influenced by value judgements as it is by the sifting of facts (Hogwood & Gunn 1983, p.6,109). Indeed, the selection of facts to be used in itself constitutes a value judgement. Defining the issue also involves the process of recognising different perceptions of the issue and selecting that, or those, with which to proceed. Such a process is strongly influenced by the distribution of power within society and hence by the policy culture. For these reasons public participation, by way of a process that should be defined and agreed upon, should be significant at the earliest possible stage in the policy development process, specifically involving the defining of the issue and the shaping of the values and facts.[37] The more value-laden the issue, the greater the difficulty there is likely to be in reaching consensus, according to Hogwood and Gunn (1984, p.118).

Gerston (1997) separated issues requiring public policy responses into those that are substantive and those that are symbolic. He allocated the former description to such things as economic regulation, welfare reform, environmental protection, and social issues such as abortion and gun control: issues that are complex and likely to "linger on the public agenda" for quite some time, issues which attract "massive amounts of attention" (p.62) from the public and the policy-makers, issues which require use of public resources and contain potential for great change. The symbolic issues are more to do with questions of values than of resources, according to Gerston (1997): issues involving ambiguity and vagueness, such as 'flag-burning' and the concept of 'good citizenship'.

[37] There is a need for clarification of exactly what public participation currently entails and should entail in an ethical policy process. This subject is considered in some detail in Chapter 7.

To respond to a substantive issue with a symbolic or token response is likely to only prolong its stay on the agenda, warned Gerston (1997). Governments may acknowledge the problem, but do only enough to "soothe the alienated elements whilst producing minimal change" (Gerston 1997, p.66). It may take this approach for a number of reasons:

- because it perceives the issue to be derived from narrowly based groups and concern is not broadly spread through society;
- because it is influenced by powerful interest groups that are opposed to change, and Gerston specifically pointed to farmers' organisations as a notable example of a close association between an interest group and the government in the USA— the same would be true for Federated Farmers and National governments in New Zealand;
- because the problem is so multifaceted that policy makers cannot achieve any consensus over how to resolve it, and Gerston cited health policy in the USA as an example of this.

It is contended that the public concern about pesticides is one of Gerston's substantive issues, one that has lingered long on the agenda, and that has been influenced by powerful lobby groups. The symbolic response to it, to date, in New Zealand, has been to largely dismiss that concern as a figment of ignorant and irrational minds.[38] A new registration system is being put in place under the HSNO Act 1996, but it is not expected, by the concerned community, to make any significant difference to the number or type of pesticides registered, or their use patterns. There has been some degree of substantive response in the recognition of the issue of spray drift, although the proposed regulation has fallen well short of the wishes of those members of the public who believe the drifting of any spray onto private property to be an infringement of their rights, as referred to earlier in section 1.2.2. But the wider questions, those that touch on society's underlying value systems, remain unanswered: is the country really so dependent on pesticides, does it have a future as a nation committed to organic agriculture, is there a middle way of risk reduction, how should it prioritize human health and export earnings?

[38] For example, in 1996 the Minister of Agriculture followed his announcement of a new basic chemistry course in the curriculum for junior schools with the following comment: "And you need no further evidence that we have been weak in that area when you hear people demand that they don't want any chemicals in their food, or anything else. Presumably these people are too afraid of chemicals to risk inhaling oxygen into their lungs" (Smith 1996, p.2).

One of the most important aspects of shaping the issue, and in determining the policy response engendered, is that of deciding what type of policy issue is involved. Gerston (1997) divided "most controversial elements" (p.16) of public policy into three main areas: social, economic and technological issues. He noted that governments tend to minimize their involvement in issues involving social change, to approach economic issues with their own set of values, and to let technology takes its own course. This divide echoes that of Jürgen Habermas's social theory, which revolves around the technical-instrumental dimension of society on the one hand, and the moral-practical dimension on the other (Forester 1993, p.12). Generally, policy makers tend to regard pesticides as a technical issue relating to efficacy, productivity, occupational safety, scientifically supportable levels of pollution of the groundwater, etc. Such an approach is evident, it is contended, in the policies of countries such as the UK, USA, Australia, and New Zealand, where emphasis is placed on ensuring that users will continue to have access to all the pesticides that they are perceived to require, whilst at the same time reducing some of the more obvious adverse impacts. Moral/ethical issues are regarded by the supporters of this approach as playing no part in the technical/instrumental dimension, and hence as lying outside the arena of pesticide policy.

Yet there is a problem with this approach. As has already been indicated, it avoids the need to scrutinize, and therefore perhaps to adjust, the underlying values and assumptions based on those values that are vital in determining the outcome of so-called technical decisions. It, therefore, prevents scrutiny of some of the ethical and social issues relating to pesticide use. Sweden's pesticide policy is notable for having addressed at least one of these issues: the banning of aerial spraying of forests in order that the traditional right of common access to the forests might be maintained:

> An ancient and unwritten law called "everyman's right" entitles everyone to walk in the forests, pick flowers, berries, and mushrooms, and if travelling, to sleep (one night) wherever night falls.
>
> Bellinder, Gummesson & Karlsson 1994, p.351.[39]

[39] Merchant (1996, p.176) related how this banning of aerial spraying came about: "Marit Paulsson of Ytter Malung in central Sweden and a group of women invited members of the executive branch of the Swedish government to taste preserves made from raspberries sprayed with herbicides by the forest industry. The officials, who were filmed on national television, refused. Taking their preserves to spokesmen for all of Sweden's political parties, the women raised massive public opinion against

Some ethical issues, such as the 'rights' of future generations, are indirectly supported through efforts to reduce contamination of groundwater, although these issues are generally not perceived in an ethical light but rather in a technical light. One of the failings of most, if not all, pesticide policies is the reluctance to acknowledge, explore, and address ethical and social issues: issues such as the place of cultural principles, the ecocentric ethic versus the anthropocentric ethic, the ethic of continual improvement,[40] the ethic of alternatives,[41] and ecological rights generally.[42] These ethical and cultural aspects of pesticide use will be more fully explored in Chapter 5, and some of the wider social effects of pesticides reported to occur in Asia will be found in Chapter 6. Ethical, cultural and social implications of pesticide use cannot be ignored in an ethical pesticide policy, and they draw attention to the blurring of the distinction between the technical and the social that is espoused by the advocates of the scientific/instrumental approach to policy making. It is the social effects and ethical aspects of pesticide use that have finally elevated this issue to the public policy agenda in New Zealand, not their technical aspects, and it is the perceived economic benefit of their use that has kept them off the agenda for so long. By rights, therefore, pesticide policy should be regarded as social policy, rather than merely technological policy.

In order to strengthen this assertion, a closer look at the nature of social policy is called for. Cheyne, O'Brien and Belgrave (1997), in attempting to arrive at an overall definition of social policy for New Zealand, quoted several other authors:

> [Social policy is] the rationale underlying the development and use of social institutions and groups which affect the distribution of resources, status and power between different groups in society. Thus, social policy is concerned both with the values and principles which govern distribution as well as their outcome.

herbicides. As a result, a law was passed in 1979 prohibiting the use of herbicides in all forests (although local authorities may make exceptions)." Merchant cited her sources as an interview with Marit Paulson, April 16, 1984; *Miljotidningen*, no 6 (1977):6-11; *Vi manskor*, no 2 (1978):26.

[40] New Zealand's Ministry for the Environment (MfE 1997) stated the view that the concept of sustainable management "requires an ethic of striving for the best management practices and continual improvement" (p.7), but they failed to incorporate this ethic in their pesticide policy, the HSNO Act 1996 and its regulations.

[41] Referred to by Peter Montague (1996), and attributed by him to Robert Goodland of the World Bank: "to be ethical, the project with the least environmental impacts should be selected" (Goodland 1993). Applied to pesticide policy, this would mean that pesticides must be weighted against non-pesticide management methods and those with the least environmental impacts selected.

[42] In which human rights are subject to "limitations that recognize that individual freedoms are exercised in an ecological context, in addition to a social context" (Taylor 1998, p.309).

Walker 1984, p.141, cited in Cheyne *et al.* 1997, p.141.[43]

> Social policy concerns the way in which society meets its collective responsibilities by enhancing human development and advancing social well-being.
>
> Shirley 1990, p.132, cited in Cheyne *et al.* 1997, p.5.

Cheyne *et al.* (1997) also noted that the Royal Commission on Social Policy, established in 1986, referred to the development of a "fair society", and "the maintenance and enhancement of well-being" (p.12). In fact, virtually all areas of policy, except foreign affairs and defence, were seen as integral to social policy.[44]

After considering these various approaches to social policy, Cheyne *et al.* eventually arrived at their own definition:

> Social policy is defined here as actions which affect the well-being of members of a society through shaping the distribution of and access to goods and resources in their society.
>
> Cheyne *et al.* 1997, p.2-3.

The authors then identified some of the goals of social policy as acknowledging the dignity and rights of individuals, treating people fairly, and enhancing social cohesion (Cheyne *et al.* 1997, p.46,49). It is contended that these goals should form an under-lying platform upon which all other policy, including that of pesticides, is built. They should inform the direction and aim of ethical pesticide policy. Note the first quote above, from Walker, and in particular the reference to "the distribution of resources, status and power". The current distribution of power with respect to spray drift in New Zealand has already been described in section 1.2.2. This issue of distributive justice is one of the more powerful reasons for regarding pesticide policy as a social issue. It involves not just the intergenerational equity issue of spray drift, but also the intragenerational issues of environmental contamination and loss of biodiversity: the reaping of benefits by the present-day user and the deprivation that might be suffered by future generations.

Yet, despite their obvious nature, these problems relating to pesticide use are rarely couched in terms of distributive justice. Peter Berger, in *The Pyramids of Sacrifice*, captured well the issue of social pain inflicted by inadequate attention to issues of

[43] Christine Cheyne, Mike O'Brien, and Michael Belgrave, Department of Social Policy and Social Work, Massey University, Palmerston North and Albany.

[44] Treasury, strongly opposed to state intervention, reacted in 1987 to this broad approach with their own definition: "social policy is simply that list of activities that are normally understood to be social policy" (Treasury 1987, p.394, cited in Cheyne *et al.* 1997, p.10).

distributive justice in his comparison of the common moral basis of two radically opposed systems of political belief: modern industrial capitalism based on the premise of continued economic growth, and socialist ideology based on revolution. That moral basis is "the willingness to sacrifice at least one generation for the putative goals" (Berger 1974, p.xiii). Berger illustrated this with reference to two large-scale ideological 'experiments'. On the one hand was Brazil, in which the desired economic growth was achieved, but at the expense of the distribution of the fruits of that growth, with attendant increased unemployment and worsened poverty of the large percentage of the population that is poor. Berger (1974) stated that the Brazilian model "condones the starvation of children as an acceptable price for economic growth" (p.146). On the other hand was China, in which economic growth was lower but egalitarian principles ensured redistribution of wealth so that starvation was virtually eliminated. The cost was the terror of the revolutionary regime, that in Berger's words "succeeded in making one of the liveliest peoples in the world walk the streets without noise and without laughter" (p.156). Berger concluded that in both cases "the sacrifices are indefensible" (p.xiii).

What have these extreme examples of political ideology, both based on regimes of terror, got to do with pesticide policy? The answer to that question can be found in Berger's derivation of the term 'the calculus of pain', an assessment of human costs in terms of deprivation and suffering, from his analysis of the effects of the two ideologies. He concluded:

> It is presupposed that policy should seek to avoid the infliction of pain. It is further presupposed that, in those cases where policy does involve either the active infliction or the passive acceptance of pain, this fact requires a justification in terms of moral rather than technical necessity.
>
> Berger 1974, p.139.

Any policy on pesticides is likely to involve the infliction of some degree of pain on someone. If the policy supports the user's right to drift spray, then the pain is borne by the neighbour as anxiety, ill health, and/or lost crops. If the policy seeks to withdraw that right and defend the neighbour, then the user may experience a degree of economic and/or psychological pain in the curtailing of her/his activities. Berger maintained that the choice between the two should be justified on moral rather than technical grounds. Supporters of the liberal/instrumental rationality approach maintain it should be justified on economic grounds backed by scientific rationality. The latter approach finds expression in consequentialist type policy in which outcomes, frequently expressed as risks and benefits, are the basis of decision-making (Brunk, Haworth & Lee 1998, p.126-

7). Berger's moral ground's approach best finds expression in policy that includes extra-consequentialist considerations such as the kind of society we want, and whose claims to rights should prevail, i.e. social policy.

Hence, whilst the term social policy is commonly used to refer to policies on health, housing, and education, it is evident from the preceding description of the goals of social policy that the use of pesticides involves social principles, not the least of which is distributive justice, and that therefore policy relating to pesticide use should contain strong elements of social policy. Acknowledging pesticide use as a social issue would necessitate scrutiny of the social issues involved, principally those of the distribution of power and status between users and non-users. To regard pesticides as merely a technical policy issue, and that solely of agriculture, enables the important social dimensions and changing societal values to be ignored.

1.3.3 Implementation

The policy process includes implementation as well as formulation, and the success of the policy depends ultimately upon the success of implementation. Yet it is often overlooked in the policy development process. The actual policy tools used for implementation lie outside the scope of this thesis, which is more concerned with process, but the subject is noted in passing as one of importance.

The success of implementation will depend in part on the attitude and commitment of government players, and in part on those sectors of society who are the recipients of the effects of that policy, those who lie in its path (Gerston 1997). A policy has a better chance of success if it results from the interaction of those who have demanded the change, those who make the decisions and formulate the policy, and those who are affected by it. Gerston (1997, p.99) identified three additional conditions for successful implementation:

- it is assigned to an agency with sufficient resources to carry it out;
- this agency must translate goals into an operational framework; and
- it must actually carry out its task and be accountable for its actions.

Hogwood and Gunn (1984, p.197) commented that, if a policy is deemed to have failed, it is important to determine whether this was because of non-implementation or unsuccessful implementation—where the former refers to the policy not being executed as intended (sometimes deliberately), and the latter refers to the policy being carried out as intended but nevertheless failing to produce the intended results. A third scenario,

particularly relevant to agriculture, is that of luck: the vagaries of markets, climate, and other unforeseeable variables may alter the short-term outcome of a pesticide policy. A fourth scenario is that of a bad policy in the first place: it was based on inadequate information, defective reasoning, unrealistic assumptions, and/or lack of support from some or all of the affected parties.

A policy also has a better chance of success if it is adequately funded—in fact Gerston (1997) placed primary emphasis on this factor in determining successful implementation of a policy: "simply stated, inadequate funding is a virtual guarantee of programmatic disaster at the point of implementation" (p.113). Apart from being "the hallmark of commitment" (p.106), funding is vital for planning, coordination and making policies operational. Yet the problem of "unfunded mandates" (p.106) is a very real one. The examples of this that Gerston (1997, p.106-7) laid at the feet of the Reagan Administration in the USA are well known in New Zealand too: deregulation, privatisation and decentralisation, all of which have the effect of shifting the responsibility for, and funding of, the policy apparatus to agencies other than central government. Gerston described this as "the illusion of smaller federal [sic] government while shifting responsibilities to other levels of government" (p.107) and the private sector. In 1995 the US Congress enacted legislation to eliminate unfunded mandating "except in exceptional circumstances" (Gerston 1997, p.107).

Pesticide policy in New Zealand has experienced many of these problems. The shifting of responsibility for spray drift away from MAF and on to regional councils, through the RMA, resulted in these councils struggling to deal with a problem with inadequate resources, personnel and expertise. The result has been equally inadequate from the perspective of many of the effected communities. The effectiveness of regional council approaches has varied from region to region, depending in part, it is contended, on the political will of the councils concerned. This has left members of the communities suffering spray drift problems with little recourse to a central government that has buffered itself with devolution of responsibility to regional councils, which probably didn't want that responsibility any more than the central government did. Thus, it is contended, the spray drift 'policy' of central government has largely failed in its implementation because of insufficient resources, inadequate operational framework, lack of accountability and a lack of will to resolve the problems.

Implementation is a vital component of ethical pesticide policy, and it is contended that such implementation, as well as initial policy development, must involve those who 'lie in its path': the communities of people who perceive a need to use pesticides and those

who are affected by that use. Chapter 7 will develop this theme fully. The successful implementation of ethical pesticide policy will require a significant degree of attitudinal change on the part of the traditional policy makers and policy actors, as will be discussed in Chapter 5. Unless processes are put in place to support this attitudinal change the promises of an ethical policy will not be realized.

1.4 The policy tradition in New Zealand

Regardless of the issue, its history, or the level of public concern, the particular political philosophy of the currently elected representatives will determine, to a large extent, the direction that policy development will take. Whilst that philosophy may change with changes of ruling party, a long-term overview of a country's political philosophical direction may help place the current view in perspective, and provide valuable assistance in arriving at a policy that will at once be acceptable to the current philosophy and at the same time survive a change in that philosophy. Cheyne *et al.* asserted that:

> Notwithstanding the current dominance of neo-liberal thought . . . liberal democratic government is at a point of transition. Aspirations for more effective democracy are producing reassessments of the role of the state, central planning and the bureaucracy.
>
> Cheyne *et al.* 1997, p.143-4.

Therefore, a pesticide policy needs to be able to absorb those possible changes, even to predict them, at the same time that it meets the requirements of an ethical approach as will be described later in this thesis.

The policy culture in New Zealand involves two main cultural traditions, that of the dominant western value system of the pakeha, and that of the indigenous Maori people.[45] It is often assumed that Maori people hold one common view as to their cultural traditions, and as will be demonstrated this is not correct. There are in fact sharply divergent views within Maoridom as to the role of their own cultural values in public policy. Similarly, there is a tendency to present the pakeha culture as a homogenous whole, typified by the predominant scientific and economic paradigms which operate on a reductionist, mechanistic philosophy, separating each compartment of the environment and especially separating humans from the ecosystem. In this process the western liberal paradigm sees itself as not only separate from, but superior too, the surrounding environment, putting its social and economic desires ahead of the

[45] Pakeha means person of European descent (Williams 1975, p.252).

ecological requirements of non-human nature. Again, it is a mistake to assume pakeha culture equates with this paradigm. Certainly this philosophy dominates current policy making, but it does not fully represent pakeha culture in its entirety. This divergence in philosophical approaches plays an important role in the lay assessment of risks relating to pesticides. It will therefore be considered in depth in Chapter 5. For now, analysis of cultural tradition will be limited to those two that exert the main influence on the policy culture in New Zealand, the western and the Maori traditions.

1.4.1 The western tradition

New Zealand's policy culture has been described by Cheyne *et al.* (1997) as being predominantly "pragmatic and conservative" (p.18), and based on the Western liberal political philosophy of democracy, equality, and personal liberty, over the years since the state's formal inception in 1840 (p.51). There have been brief periods of "reforming zeal" that set the culture for the ensuing decades, such as occurred with the 1840's "experiment on sustainable colonisation", the 1890's "state socialism", and the 1930's introduction of the welfare state (Cheyne *et al.* 1997, p.17). The more recent swing to neo-liberalism in the 1980s and 90s is but the latest example. Yet, despite these lurches left or right, the predominant policy culture has settled over the decades into a liberal mode, in which the state has had a largely directive role rather than a distributive role, even during the development of the welfare state when, for example, employment-based support was preferred to direct state support (Cheyne *et al.* 1997, p.25-6). New Zealand's brand of liberalism has involved rather more state management of the economy than that envisaged by the nineteenth century proponents of *laissez-faire* free-market liberalism Thomas, John Locke and John Stuart Mill.[46]

However, New Zealand's current policy culture is dominated by neo-liberal idealism, harking back to its free-market origins in nineteenth century liberal political philosophy. In its current form, it was introduced by the Labour Government in 1984, and extended by the National governments since 1990.[47] Economic policy has been given primacy over social objectives, the free-market encouraged and the role of the state diminished:

[46] Liberalism is a relatively loosely defined political concept, largely because it owes its origins to a number of different writers, and because it has evolved over the years and in different countries into slightly different forms. Generally, it promotes individualism and holds that the state's role is to foster that individualism through limited, and only were necessary, intervention to protect individual's interests against harm done by others. It also has a role in providing stability for the market, which is seen as the provider of all wealth.

[47] It is contended that the Labour government elected in 1999 is still in neo-liberalist mode, although Cheyne *et al.*'s transition is beginning to occur. There is certainly a greater emphasis on social objectives, although the free-market policy has not substantially changed.

> An appropriate role for the state in many areas is to define a clear set of rights for people and to permit individuals to voluntarily transact between one another in order to pursue their own well-being.
>
> Treasury 1987, p.124, cited in Cheyne *et al.* 1997, p.84.

Treasury advisors have developed a powerful influence over policy, according to Cheyne *et al.* (1997, p.42).

Access to, and control of, land have been major lynch-pins in New Zealand's policy culture, firstly as an ownership issue, particularly the removal of land from Maori control to pakeha control, and then as the exercising of private property rights. However, the achievement of these two ideals has involved vastly different roles for the state: pakeha land ownership was largely achieved through state intervention, partly based on the "utopian single-family, single farm" ideal (Cheyne *et al.* 1997, p.30), whereas private property rights are seen as being independent of, although supported and protected by, the state. Neo-liberalism has placed even greater emphasis on the private property rights as the embodiment of individual freedom. Along with this freedom comes an equal emphasis on personal responsibility, both in terms of responsibility for one's own destiny, and in terms of one's effects on others: "an individual's freedom to do what she/he chooses needs to be constrained to the extent that another individual's freedom to pursue self-interest is not diminished" (Cheyne *et al.* 1997, p.89).

Policy development under this political direction has seen the intensification of what (Cheyne *et al.* 1997, p.136) referred to as "technical rationality", where Berger's 'engineering' approach is taken to policy development. This has involved subordinating social questions to economic arguments. It has also involved the subordination of social questions to scientific rationality. Increasingly, policy is being developed on the basis of 'sound science', the term intimating that science is neutral, value-free, the 'truth' that cannot be argued against.[48] This "technocratisation" (Cheyne *et al.* 1997, p.138) of policy development emphasizes technical skills and instrumental rationality as opposed to social understanding. Yet this technical rationality of policy development, in fact, goes against some of the basic tenets of liberalist and neo-liberalist thought, in particular private property rights and individual freedom. For technical rationality ignores these issues. It fails to identify and hence to resolve the private property rights involved in spray drift issues. The technical rationality approach also emphasizes pragmatism, in terms of acceptability to the political powers as much as in terms of administrative practicality: Cheyne *et al.* (1997, p.136) referred to a "sense of inevitability" in current

[48] This claim will be analysed in depth in Chapters 3, 4 and 5.

policy prescriptions, arising from more than a decade of public sector reforms. Certainly the author's experience as a member of the Pesticides Board, would support that comment. As an example, when a consensus has been reached in various working groups on spray drift that there should be compulsory registration of commercial users of pesticides, the idea has NOT been advanced because of sure knowledge that the government was opposed to compulsory measures. So the choice not to pursue compulsory registration was made not on the basis of sound policy, indeed probably in direct contrast to sound policy, but on the basis of the government's ideology.

1.4.2 Maori cultural tradition

At the same time as the pakeha dominated political direction has embraced neo-liberalism, there has been an increasing awareness of racial issues, and increasing emphasis placed on the constitutional importance of the Treaty of Waitangi, signed by the two partners Maori and pakeha. The result has been greater acknowledgement in policy making of the second, parallel cultural tradition, that of the indigenous Maori people. The RMA specifically requires consideration of Maori cultural interests:

> The relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga.
>
> RMA, section 6 (e).[49]

> all persons exercising functions and powers under [this Act] . . . shall have particular regard to-
> (a) Kaitiakitanga.
>
> RMA, section 7 (a). [50]

> In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).
>
> RMA, section 8.

The more recent HSNO Act 1996 has taken this apparent inclusiveness one step further: ERMA, set up under the Act to process registrations of hazardous substances and new

[49] Waahi tapu means sacred place; taonga means highly prized (Williams 1975).

[50] Kaitiakitanga is defined as being "the exercise of guardianship by the tangata whenua of an area in accordance with tikanga Maori in relation to natural and physical resources; and includes the ethic of stewardship" (Resource Management Amendment Act 1997, section 2(4)). The Amendment Act also added the ethic of stewardship as a separate consideration (section 7(aa) of the principle Act), presumably as a non-Maori ethic. Tikanga Maori means cultural and spiritual norms; defined by the RMA as meaning Maori customary values and practices.

organisms, has established a consultative group, Ngā Kaihautu Tikanga Taiao, with the function of providing advice on how applications will affect Māori (ERMA 1998, p.7).[51] Additionally, all applicants are required to consult with Māori on the nature of risks to their cultural interests, and to include the results as part of the risk-benefit assessment.

Early indications are that this process may not work, that the consultation may be merely tokenism, and the results of consultation will not be reflected in the decision-making process. One example of such consultation that could not be regarded as adequate is a three page letter by Cropmark New Zealand to a group of Northland Māori. The letter sought their views regarding the proposal to register the genetically modified organism Roundup Ready Canola. In this letter, Cropmark informed the recipients that:

> Roundup is not residual and [is] non toxic to humans and animals, and Roundup will not get into ground water.
>
> Patchett 1998, p.2.

None of this is quite true.[52] Other examples of problems regarding the inclusion of Māori cultural views in ERMA's policy decisions will be provided in Chapters 5 and 7.

It is difficult to see how traditional Māori cultural principles can be reconciled with the western liberal technical rationality approach of risk-benefit balancing. Part of this difficulty lies with the fact that Māori, although theoretically equal partners in a bi-cultural nation, in fact constitute less than 20 percent of the population and thus the significance of the risks to Māori cultural requirements will always be secondary to aspirations of the pakeha paradigm in a risk-benefit model. Cheyne *et al.* (1997, p.47) referred to the Māori worldview and values that emphasize "a unity between the spiritual and material worlds", a view deliberately excluded from the currently predominating western science-based policy culture. A fundamental Māori cultural principle is the preservation of te mauri, the life principle, a hidden principle protecting vitality:

[51] Kaitiakitanga has NOT been included in this Act, although the Treaty of Waitangi, and "the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga" have been.

[52] Glyphosate, the active ingredient of Roundup, was described by the US EPA (1993) as relatively persistent, with a half-life in soil as high as 140 days depending on soil type. Recent scientific studies indicate that Roundup may cause non-Hodgkin lymphoma (Nordstrom, Hardell, Magnuson, Hagberg & Rask-Anderson 1998; Hardell & Erickson 1999) and disrupt reproductive function (Walsh, McCormick, Martin & Stocco 2000). Roundup has been found in groundwater (IPCS 1994).

> Te mauri whenua (the life force of the land) and te mauri o nga awa tapu (the life force of the sacred rivers) and Te Moana o Pikopiko i Whiti (the sea of the inner Bay of Islands) is essential for the preservation of our food baskets which our people still rely upon on a daily basis. We consider that by ignoring our fundamental cultural principles it is an affront to us as Tangata Whenua, together with our values and very existence.
>
> Marks 1996, p.149.

Te Mauri has been interpreted by some pakeha, it would seem, to equate with the western scientific values of environmental bottom lines, or acceptable levels of pollution. This is illustrated by the case *Marie Philomena Grunke v Otago Regional Council* C008/96 involving an enforcement order, sought under section 311 of the RMA, to prevent the Regional Council spraying the herbicide Roundup GII on the banks of the Kakanui and Kaura Rivers. The Planning Tribunal Judge (Judge Skelton) interpreted a lack of scientific proof of potential to damage human health or the environment ("no grounds exist to claim that proposed spraying is harmful to health or the environment") as meaning that the use of the herbicides does not contravene Maori cultural principles ("and on that basis the spiritual grounds must also fail").

But is this the Maori view of their own cultural principles? Does preserving te mauri whenua and te mauri o nga awa tapu equate to environmental bottom lines? Is there a point up to which pollution is acceptable to Maori, and beyond which te mauri is destroyed? Is 100ppm of 2,4-D in nga awa tapu, the legal 'acceptable' level in New Zealand, consistent with te mauri? Or are the European and Scandinavian policy cultures more compatible with Maori cultural values? In Europe the legal 'acceptable' level of pollution of water by any individual pesticide is 0.1ppm. This level was based on the twin premises that no contamination of water is acceptable and this is the minimum that could be detected by science. Sweden has proposed a goal of zero residues in water and in food.

How, then, will ERMA reconcile their risk-benefit approach with tikanga Maori, the cultural and spiritual norms, philosophical bases and practices of the Maori? Most likely in the manner in which Judge Kenderdine found in the *Wellington Biosolids* case, that is in favour of pragmatism, and against tradition.[53] In this case, opposing Maori views were presented as to the cultural offensiveness of the proposed composting of material containing human tissue: on the one hand the traditional view of tikanga Maori, and on

[53] *Te Runanganui O Taranaki Whanui Ki Te Upoko O Te Ika A Maui Inc v Wellington Regional Council and Wellington City Council*, Environment Court, W48/98, 8 July 1998, Judge Kenderdine.

the other the 'pragmatic' view of it. The pragmatic view held that traditional Maori values were 'dynamic' and 'evolving' in response to the changing environment and human knowledge. The decision in favour of "the informed 'pragmatic view' which 'grasps the possibilities of new technologies and understanding'" (p.12) was interpreted by Daya-Winterbottom (1999) as being determinative of issues relating to Maori cultural and spiritual values.

If Maori cultural values are therefore to be interpreted 'pragmatically' in terms of western scientific standards, then there seems little substance to the legal recognition of Maori cultural values and traditions as separate from those of the dominant European system. It is interesting to note that the determination in favour of the pragmatic view of Maori traditional values was made by a non-Maori during a non-Maori judicial process. The extent to which this view is supported by Maori other than by the Maori leaders who espoused it during that process, Sir Tipene O'Regan and Morris Te Whiti Love, is not yet apparent. What has become apparent is that the theoretical existence of two separate cultural systems has become reduced, at a practical policy level, to one value system, that of the dominant western tradition. It is contended that ethical pesticide policy must reverse this process and accord due status to Maori cultural tradition within the policy process, as will be discussed further in Chapters 5 and 7.

Conclusion

This brief tour of the public policy process has looked at the traditional approaches to policy development based on instrumental rationality, using New Zealand pesticide policy to demonstrate where they fail at a social level. The outcome can be divided into two parts: a sketch of what constitutes New Zealand's pesticide policy, and findings that will assist in the development of an ethical pesticide policy process.

Firstly, New Zealand's pesticide policy. It exists as a set of statutes: the Pesticides Act 1979, the RMA 1991, the HSNO Act 1996 and its regulations, and the ACVM Act 1997. To a lesser extent it also exists in the Health Act 1956, the Toxic Substances Act 1979, and the Health and Safety in Employment Act 1992. The Pesticides Act promotes the prudent, effective, and safe use of pesticides. The HSNO Act makes a policy statement about protecting the environment, and the health and safety of people and communities, by preventing or managing the adverse effects of hazardous substances and new organisms. The apparent values it frames are those of environmental protection and human health and safety, but it is contended that the primary purpose of HSNO is not

the protection of the environment and the health of the community, but rather the approval for use of hazardous substances and new organisms. Thus, the primary policy objective is to facilitate pesticide registration. This is confirmed by the Annotated Methodology, which clearly indicates the aim of registering most pesticides for which registration is requested. That is a policy statement, apparently based on a premise that pesticides are desirable without considering whether or not they are actually needed. Further policy statements can be found in the requirement that risk assessment and risk management techniques be used to achieve implementation, and that cultural impacts be considered. It is contended that the emphasis continues to be placed on an approach that embraces economic utilitarianism underpinned by the instrumental rationality of science, with scant consideration of the ethical and the cultural in actual practice.

Pesticide policy exists also as a presumptive right of pesticide users to drift spray across the boundary of the property on which the pesticides are being applied and into neighbouring private property and the wider environment. The presumptive right exists as long as no provable adverse effects occur, and is supported by laws such as the RMA 1991, the Health Act 1956, and the Health and Safety in Employment Act 1992, all of which require the casual proof of adverse effects that in reality is virtually impossible to achieve. Thus the rights stay with the drifter. The proposed HSNO regulations will remove the need for causal linking of effects, remove the presumptive right for levels of drift above 'Tolerable Exposure Limits' and confirm the presumptive right as a legal right for drift below those limits. This right to drift stems from the twin beliefs that it is not possible to apply pesticides without there being cross-boundary drift, and that it is not possible to undertake agriculture without applying pesticides. Therefore, it is presumed that the primary right should belong to users of pesticides because they have a perceived economic need. It is also supported by the rights of existing use approach under the RMA.

Pesticide policy exists in the failure of the regulatory mechanism to require those who use pesticides to pay the full costs of the externalities, i.e. the costs of the adverse effects on human health, the agri-ecosystem and the wider environment. It exists also in the failure to provide the consumer faced with purchasing food full information regarding the residues in that food and the wider costs of pesticide use. These omissions are policy statements about the primacy of the pesticides over other considerations.

Pesticide policy exists in the bureaucrats' silences about organic agriculture, in the way that policies are named, framed and shaped. It exists in the jargon that is used, that of

expert assessment and *public perception*, which creates a bias against the public's views and values.

Pesticide policy exists in the law courts' interpretation of Maori cultural principles in terms of scientifically-derived estimations of environmental effects.

The analysis has illuminated the true nature of pesticide policy as social policy, involving a range of social issues and values, rights and entitlements that play a central but seldom acknowledged role in pesticide policy, and their importance will be emphasized throughout this thesis as a central theme. In the process, the traditional approach to pesticide policy as a matter solely for technical deliberation, as a subject for the problem-solving, rationalistic, 'scientific' models that tend to reduce social and political questions of values to seemingly technical matters, is rejected. The development of public policy is a value-laden activity that carries consequences for all of society. It involves implicit and explicit judgements, and is constrained by the perceptions, values, biases and knowledge of those who develop it. It is contended that ethical pesticide policy must lay bare these hidden elements and ascertain what it is that society wants and needs.

This analysis has also drawn attention to a number of other areas that will be developed in depth in subsequent chapters, including the nature of risk assessment and of rationality. It has argued that implementation is a vital component of ethical pesticide policy, and it is contended that such implementation, as well as initial policy development, must involve those who lie in its path: the communities of people who perceive a need to use pesticides and those who are affected by that use. Chapter 7 will develop this theme fully. The successful implementation of ethical pesticide policy will require a significant degree of attitudinal change on the part of the traditional policy makers and policy actors.

Finally, it has been determined that, in order to reduce the unwarranted bias of policy language, the terms *technical assessment* and *lay assessment* will be used instead of the more common *expert assessment* and *public perception*. These two types of assessment form the subject matter of the next three chapters.

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Chapter 2 Lay Assessment—the Public View

Introduction

The previous chapter has established the basis for the development of public policy, in the process drawing on the existing and historical New Zealand pesticide policy situation, with some reference to that of other countries. The next task is to look more closely at one of the issues that necessitate the development of a different kind of pesticide policy: public assessment of the risks associated with pesticides, the expression of that assessment, and the reasons for arriving at it.

For decades scientists and policy makers have been bedevilled and perplexed by the disparity between the views of the experts and the attitudes of the public towards risks. The public may underestimate or over-estimate the risks, according to the view of scientists. Typically, writers report that the public tends to underestimate personal risks arising from smoking, diet, driving cars and climbing mountains, and to overestimate risks associated with the nuclear and chemical technologies (e.g. Peterson & Higley 1993, p.207; Zeckhauser & Viscusi 1996, p.149). The debate over pesticides is fertile ground for entrenched differences in perception of risk by technical and lay assessors, in which the technical assessor is generally seen to focus on a narrow range of consequences amenable to quantification, whilst the lay assessor, according to Howard Margolis (1996, p.1), has "a much richer sense of what is involved in choices about risk".[1] Paul Slovic (1992) noted that where chemicals are concerned "there appears to be little relationship between the magnitude of risk assessed by experts (health physicists, epidemiologists, and toxicologists) and the magnitude of perceived risks" (p.127). This point is endorsed by Margolis (1996): "sharply polarized expert/lay conflicts . . . are characteristically about subtle risks", such as those deriving from chemicals and radiation (p.118). Yet curiously, according to information presented by both Stephen Breyer and Slovic, there is a remarkable degree of consistency between technical and lay ratings of pesticides as a risk.[2] Breyer (1993, p.21) presented information from the US EPA in which the public rating for pesticide risks was seventh highest out of twenty-six environmental problems, and the US EPA rating was 'high' (as opposed to medium or low); eight other risks were

[1] Margolis, Professor of Public Policy Studies, University of Chicago, USA. Margolis used this argument to undermine assessment by the public rather than to legitimate it (p.99).
[2] Justice Stephen Breyer, Chief Judge, United States Court of Appeals for the First Circuit.

also rated 'high'.[3] Slovic (1987, p.281) reported that, out of thirty risks, pesticides were rated ninth by the League of Women voters and eighth by the 'experts'. These results could be used to 'prove' that there is no disagreement between the public and the experts regarding risks from pesticides. However, such is not the case as a vast amount of literature by technical experts, the media and public interest groups reveals. Perhaps the debate is, then, really about the acceptability of those risks and who decides that they are acceptable, a subject that will be scrutinized in Chapter 3. For now, the debate will be analysed in the terms in which it is presented: that of differing technical/lay opinion of riskiness.

This chapter, therefore, will set out some of the evidence of public attitudes, which may be alternatively expressed as the results of lay assessment of pesticides. It will then provide an analysis of some of the reasons why this assessment may differ from that of the technical expert. In so doing, it will provide validation of lay assessment and hence its relevance to pesticide policy development.

2.1 Gauging the attitude of the public

There are a number of ways in which public attitudes towards pesticides may be expressed, and hence may be gauged. One way is through attitudinal surveys. These often come with attendant problems of bias on the part of the survey developer, as will be demonstrated with one New Zealand survey. Such bias may seriously skew the results and limit the usefulness of the survey in accurately depicting public attitudes. Nevertheless, if there is a sufficient quantity of survey results available, they may provide a reasonable gauge of attitude. As only a very small number of New Zealand surveys have included questions on pesticides, and only one was designed specifically to test attitudes towards them, the results of several overseas studies will also be analysed.

Another way to gauge attitudes is to take the broader approach of reviewing community activity in response to pesticide use. This approach can add depth to the results of the attitudinal surveys. One such activity has already been mentioned in Chapter 1: the drafting of the Agricultural Chemical Trespass Bill. It will be considered in greater depth in this chapter, together with another community initiative, the development of Auckland City's Weed Management Policy. Other community activities, like petitions

[3] Breyer's source was Frederick Allen, US EPA, based on the EPA report *Unfinished Business: A Comparative Assessment of Environmental Problems*, 1987, and national public opinion polls by the Roper Organization in December 1987 and January 1988.

against spray drift and submissions to local, regional and central government, could also be considered in such an exercise. However, they are merely noted in passing here, for this thesis does not set out to provide a definitive analysis, but rather an overview of the situation upon which the development of pesticide policy can proceed. Horticultural industry initiatives to reduce pesticide use can also be seen as a response to, and therefore a gauge of, public concerns, but in the New Zealand context such responses have occurred largely as a result of overseas consumer concerns reflected in the export markets, rather than as a response to the New Zealand public's concern.[4] They will not, therefore, be included in this analysis.

2.1.1 Attitudinal surveys

Attitudinal surveys are commonly used to elicit public opinion on a range of issues but, as noted already, they may be prone to problems of bias or distortion. That bias, either intentional or unintentional, stems usually from the survey designer, and may also be injected by the person who asks the actual questions. Baruch Fischhoff (1996, p.80) pointed out that the survey method chosen reveals something of the value placed on public opinion within the political process: the less effort taken to obtain an accurate understanding of it, the lower the value placed on it.[5]

Fischhoff's (1996) contention that public opinion polls are unsuitable for obtaining correct information on public values (p.79) is lent weight by other writers such as Brian Wynne and Ray Rappaport.[6] Wynne (1992, p.282) drew attention to the problem of a meaning for risk being imposed, rather than elicited, during attempts to gauge attitudes towards environmental and health risks associated with technology. Rappaport (1996, p.69) echoed Fischhoff's concern that the structuring of questions in opinion polls in a manner that renders them easily administered and answers analysed, requires the forcing of representations of the various cognitive structures out of which such opinions arise into preferred quantitative terms, or else their dismissal as unquantifiable. Either route misrepresents reality, and the views elicited are restricted and devoid of the nuances that characterize value systems. Such a criticism applies to many of the survey results provided in this chapter:

[4] These initiatives include the kiwifruit industry's programme 'Kiwigreen', the apple industry's Integrated Fruit Production Programme, and the Winegrowers Integrated Wine Production system.
[5] Fischhoff, a professor of social and decision sciences and of engineering and public policy at Carnegie Mellon University, USA.
[6] Wynne, Reader in Social Science and Research Director of the Centre for the Study of Environmental Change, Lancaster University. Rappaport, Walgreen Professor for the Study of Human Understanding, University of Michigan.

> The aesthetic considerations of affected populations, for instance, or violations of their religious beliefs or of their conceptions of equity or even of their vague conceptions of the good life cannot be ruled inadmissible because they resist quantitative representation, for they are likely to be those aspects of their lives that those populations take to be most seriously at risk. Such considerations cannot be disqualified as mere preferences or prejudices of uninformed laypeople. They are embedded in views of the world no more and no less arbitrary than other views of the world, and as such have valid claims on reality. More decisively, they are social facts and as such serve as grounds for action.
>
> Rappaport 1996, p.69.

There is a whole raft of value systems embedded in the issue of pesticide use, some of which have been referred to in Chapter 1—issues of property rights, equity and cultural beliefs—and as Rappaport asserted they are not amenable to quantification. Nor will they necessarily be elicited by simple questions about food residues in relationship to other environmental problems. Any attempt to assign monetary values to public values is even more problematic, according to Rappaport (1996), resulting in direct contradictions that render the values false. He illustrated this point with the question "'how much money is your integrity (or honesty or vote) worth?'" (p.70).

Despite the doubt cast upon the worth of attitudinal surveys by the above comments, it is nevertheless useful to review those few that are available, for they may provide at least a glimpse of the level of public concern about pesticides and what lies behind it. Earlier surveys of attitudes towards pesticides tended to concentrate simply on the issue of consumers' concern regarding the effects of residues in food on their personal health. Later surveys, however, have taken a broader approach, seeking comment on production systems as a whole and in particular on the effect of those systems on the wider environment and on farm-worker safety. This change is echoed by the approach being increasingly adopted by, for example, the UK supermarkets: with all the power of large-scale purchasers they have been able to demand of their suppliers that the fresh produce they buy is produced by 'environmentally friendly' integrated crop management systems (Batchelor *et al.* 1997). Although this approach to growing is one of attempting to minimize all adverse impacts of the growing systems on the wider environment, the predominate concern is still about pesticides: their safety in usage, environmental impacts and residues in food (Ball 1997; Gould 1997).

The situation has changed somewhat since these surveys were carried out, in that the consumer's food safety consciousness is now being dominated by the prospect, and in some cases the actuality, of genetically engineered food items. This does not mean that pesticide residues are any less of a concern, there is no evidence to suggest that. Rather the more likely interpretation is that the suddenness with which the genetic engineering technology has been introduced across the world, together with the apparent consumer lack of power to express choice, has raised this issue to rapid prominence in the public consciousness. Indeed, the most likely scenario is that the combination of concern about pesticide residues and genetic engineering will hasten the consumer preference for certified organic foods, that is food produced from systems, and processed in systems, that do not use chemically derived pesticides or plants or animals that are transgenically altered.[7]

New Zealand

By far the majority of the public opinion surveys involving pesticides that have been carried out in New Zealand have concentrated on the issue of adverse effect on personal health of food residues. Typically, Charles Lamb (1994) reported that "over the period 1988 to 1991 there was an increase from 52 percent to 73 percent of the general population who have become concerned about the use of chemicals and sprays in food production" (p.3-4).[8] In relation to this concern, Lamb also reported that a 1991 study indicated approximately 57 percent of the population were "still confident to some degree that the food which they purchase[d] is harmless to their health" (p.4).[9] The corollary of that must be that 43 percent were not confident of the harmlessness of their food, or didn't answer the question. Ruth Wilson-Salt (1996) referred to an unpublished 1990 survey of consumers in Palmerston North in which 64 percent ranked pesticide residues in the top three of seventeen food concerns (Department of Marketing, 1990).

Very little information has been gathered on concerns about the wider environmental effects and none at all on the issue of inhalation of spray drift. Other methods must, therefore, be used to ascertain public concerns on this last issue. New Zealand appears

[7] Anecdotal evidence from Auckland organic produce shops, Harvest Wholefoods and West Lynn Meats indicates that is already occurring: both report suddenly increased demand for their stock apparently concomitant with the increased media profile of genetic engineering. This is supported by a survey published in May 2000, which reported that 67 percent of New Zealanders expressed concern about genetically-engineered foods, and 78 percent of urban dwellers and 70 percent of farmers regard New Zealand's future as lying with organic production rather than genetic engineering (AFFCO 2000, p.7).
[8] Lamb, Senior Lecturer in Marketing, Lincoln University, Canterbury.
[9] Lamb did not identify the study. It is possibly Lamb, C. 1991. Attitudes of Christchurch Residents to Environmental Issues, a Household Survey. Lincoln University.

to have little information at all on public concern about effects of pesticides on farm labourers (refer Table 2.1), a concern expressed particularly in the USA (e.g. Govindasamy, Italia & Adelaja 1998).

Lifestyle and Environment Survey 1993

This survey was carried out in 1992, with a subsequent report prepared by Colmar Brunton Research for MfE in 1993 (Colmar Brunton Research 1993).[10] The objectives were to gauge the overall degree of "greenness" in New Zealand and how that awareness of environmental issues translated into attitudes and behavioural changes.

The results of this survey need to be interpreted in light of the restrictive way in which concerns about pesticides were framed by the survey design. The questions appeared to be weighted to reflect MfE's own areas of activity: energy, packaging, and recycling. The Ministry's lack of interest in pesticide issues is similarly reflected: of the thirty-one questions asked to elicit information on behaviour, fourteen related to energy and recycling and only two to pesticides.[11] There were two separate sections on packaging and recycling, which provided an additional thirty-two questions, and one on energy providing an additional eighteen questions. The section on household chemicals contained nineteen types of chemicals, mostly cleaners, but omitted pesticides like fly sprays and flea powders. Given that the framing of this survey, to reflect particular topics of interest, may well skew the answers to questions which elicit comparisons of the seriousness of environmental issues, it is noteworthy that both energy issues and packaging scored the same or only marginally higher than chemicals. A second factor that needs to be kept in mind is that a generalist survey used to elicit comparisons of the seriousness of environmental issues may elicit very different answers to those of a survey designed to identify attitudes towards pesticides alone. A third factor that would influence the usefulness of the survey results with respect to pesticides is that the emphasis of this survey was on environmental issues, not health issues. If the same survey had been run with the emphasis on health issues the results may have been very different. A final factor to consider is the framing of individual questions, in particular

[10] A random sample of 600 people aged over fifteen years was drawn from urban areas only, both metropolitan and provincial. There was no explanation provided for the omission of rural areas.
[11] Respondents were asked to indicate if they ate organically grown food, and used non-toxic or natural pesticides and weedkillers.

whether it is framed in the positive or the negative. For example, the survey asked respondents to agree or disagree with the statement "Organically grown food doesn't taste nice". Six percent agreed with this statement. However if the question had been reframed as a positive statement "Organic food tastes nice", would the rate of agreement have been 94 percent, or more or less? The results of the survey are summarized below:

- 44 percent of people considered the effect of chemicals to be a very serious environmental problem. Most concern about pesticides was shown by women aged between 30-39 (51 percent).
- 19 percent ate organic food; women aged 30-39 were the most likely to eat organic food (27 percent).
- However, 83 percent of people said they would like organically grown food available in supermarkets (91 percent of women aged 30-39).
- 6 percent thought organic food does not taste very nice.
- 21 percent used natural pesticides; women aged 40+ were most likely to use natural pesticides (32 percent).
- 75 percent didn't know enough about the chemicals in the food they ate.
- 24 percent would buy organic food even if it cost more (compare this to the 19 percent who actually do eat organic food).

In light of the above comments about the framing of the survey not much more can be read into these results other than that about half of the respondents were concerned about the effects of chemicals, including pesticides, on the environment but that this concern did not translate into consumer behaviour for any number of possible reasons, such as lack of availability of organic food and non-chemical pest control products. There did, however, seem to be strong support for organic produce particularly by women. The survey results also identified strong gender differences in attitudes towards the environment, with the 'deep green' segment being dominated by women (70 percent).[12] These gender differences are worth noting, and their relevance will become more apparent as this chapter unfolds, and with respect to multiple chemical sensitivity in Chapter 4. The implications of these findings for ethical policy development will be addressed in Chapter 7.

[12] The other options were green faddists, green pragmatists and green indifferents.

International Social Survey Programme, 1993

The International Social Survey Programme is carried out annually by academic institutions in twenty-one countries, each year addressing a different topic—in 1993 it was the environment. In New Zealand a questionnaire was mailed to a random selection of adults from the electoral role. One thousand, two hundred and seventy two valid responses were received. The results relevant to pesticides were as follows (Gendall, Hosie & Russell 1994):

- 85 percent of respondents thought pesticides and chemicals used in farming are a threat to the environment.[13]
- 55 percent of respondents sometimes bought organic produce, 36 percent never bought it.[14]

The authors noted that, despite "the increasing political emphasis on deregulation", 80 percent favoured the government passing strict environmental laws to protect the environment (Gendall *et al.* 1994, p.4).

Consumer Beliefs and Attitudes Towards Agrichemicals, 1996

This mail survey of randomly selected adults (360 respondents), carried out by Ruth Wilson-Salt (1996) as part of a Masters in Agricultural Economics, is the most comprehensive of all New Zealand surveys on the subject of pesticides, in fact the only one specific to them.[15] Wilson-Salt found that consumers ranked pesticide residues as their second highest food concern, and their fourth highest food health risk (p.90). The difference in these two rankings may be explained, according to Wilson-Salt (p.91) by a lack of control over pesticide residues in comparison with the other food health risks. However, some of Wilson-Salt's other results provide a valuable insight into another possible reason for this difference, at the same time offering a possible explanation for the differences in the assessments made by lay and technical assessors. The result of interest is that 54 percent of respondents indicated that they were also concerned about

[13] 'Somewhat dangerous' = 50%; 'very dangerous' = 18%; extremely dangerous = 17%.
[14] Always buy it = 4%; often buy it = 16%; sometimes buy it = 35%; not available = 9%.
[15] On the advice of an orchard manager, Wilson-Salt used the term 'agrichemical' in place of 'pesticide' because the manager believed that the word pesticide has "negative connotations" (p.32). The assumption is made that the term agrichemical is value neutral. In fact, the decision to replace the more commonly used term pesticide with one that is intended to alter attitudes, in an attitudinal survey, may well have influenced the results. It is an example of what Considine (1994) referred to as the use of special language to divert attention, which he illustrated with the reframing of the war-time deaths of civilians as 'collateral damage'.

pesticide use for reasons other than that of residues in food. The most common 'other' concern was that of long lasting effects on the environment (refer Table 2.1).

Wilson-Salt found also that 54 percent were willing to pay more for produce grown using integrated pest management, i.e. with less pesticide use than on conventionally grown produce. Unfortunately, there was no separate analysis of different gender and ethnic respondents.

Table 2.1 Concerns other than food safety

Concerned about	%
long lasting effects on environment	26
food chain effects & effects on beneficial species	15
overseas markets	13
long term human health effects	12
effects on people who work with pesticides	9
contamination of groundwater	8
spray drift	8
effects on health of children, e.g. asthma, rashes	5
effects on unborn child	4

Source: Wilson-Salt 1996, p.48.

It is contended that the consumer with a concern about the effects of pesticides on the environment, future generations and farm workers, etc, may consciously or sub-consciously translate that concern into an aversion to pesticide residues, for food purchasing is one of the few ways in which the consumer can express that concern. Thus the aversion to food residues may reflect what Margolis (1996, p.1) referred to as the "much richer sense of what is involved in choices about risk", derived from underlying value systems that will be elucidated later in this chapter.

The fruit production methods survey, 1997

This survey, carried out by HortResearch and the New Zealand Forest Research Institute, was primarily aimed at investigating the public attitude to genetic engineering in fruit production (Richardson-Harman, Phelps, Mooney & Ball 1998, p.182). Its usefulness here lies in the comparisons it elicited between attitudes towards different fruit production methods—genetic engineering, pesticide and fertilizer use, and organic production—and thus its indication of attitudes towards pesticides. It was a postal survey of two sets of adolescents and adults, in urban Auckland and rural Kerikeri. Five

hundred and eleven useable questionnaires were completed. The results were as follows:

- 85 percent would eat an apple organically grown to reduce chemical residues, and only 33 percent would knowingly eat an apple that had been sprayed with a pesticide.[16]
- 77 percent would eat an apple selectively bred to reduce the need for chemical residues, and 66 percent would it one genetically engineered to reduce chemical residues.

Richardson-Harman *et al.* (1998) concluded that the use of pesticides in fruit production was considered to be "unacceptable" (p.191). Male and females responses were not separated, so any potential gender differences cannot be ascertained.

The general conclusion that can be reached from the New Zealand surveys is that, by and large, the lay assessment of pesticides is one of significant risk, at least with respect to food residues. Very little information is available on the assessment of risk to the environment but where such an assessment has been expressed it is, again, of significant risk. These assessments of risk should be construed to differ substantially from those of the technical assessors involved in the registration of the pesticides for the registration process, theoretically, rejects the use of pesticides which pose significant risk. The lay assessment is additionally at odds with the technical assessment made by the Ministry of Health, which periodically informs the public that there is no significant risk from pesticide residues in food:

> In conclusion, this compliance survey demonstrates that the food supply in the 1990/91 NZTDS New Zealand Total Diet Survey] contains levels of pesticides, toxic elements, and preservatives which are generally well below established safety limits. The residues that have been found are unlikely to have any adverse health implications for the New Zealand population.
>
> Pickston & Vannoort 1995, p.2.

[16] The authors noted the disparity between the figure of 33 percent who would knowingly eat an apple that had been sprayed with a pesticide and the more than 95 percent that regularly consumed apples, given that nearly 100 percent of the apples on the New Zealand market are sprayed with pesticides. They concluded that the lack of consumer awareness about pesticide use could result from unwillingness on the part of the apple industry to make available information on pesticide use, and unwillingness on the part of consumers to access or accept such information (Richardson-Harman *et al.* 1998, p.191).

United States of America

Attitudinal surveys have been carried out in a number of countries. However, rather than review all of these, the USA has been selected for closer scrutiny because of the relatively large number of survey results available. These surveys have not been restricted to food residues, as is the case in New Zealand, but have often been broadened to include assessment of environmental effects and different farming systems. A brief review will help to expand the picture of lay assessment.

In a 1986 survey of consumers, 75 percent of respondents considered that pesticides, additives and preservatives constituted "a serious hazard" (Hammitt 1990). Carl Winter (1992) referred to a survey reported in 1990, in which 80 percent of consumers considered pesticide residues to be a major concern.[17] In 1993 Carolyn Sachs reported on a number of public opinion polls over the years from 1964 to the late 1980s, all asking questions regarding the public's level of concern about pesticides and food safety, worker safety, danger to wildlife, and groundwater contamination. These surveys found that the level of public concern had increased dramatically with, by the late 1980s, well over 70 percent of respondents expressing concern about the various side effects of pesticides. The one exception was a study of Kansas consumers of which only 45 percent ranked pesticides as one of the top three food safety concerns.

Chung Huang (1992) reported on a postal survey of 580 Georgia households, randomly selected and stratified by income and location. The subject of the survey was food safety. The result: food grown with pesticides was the top concern. Only four percent believed that "pesticides are safe and public fear is unwarranted" (p.497). Sixty one percent said they would prefer to buy organically grown fresh produce, and 45 percent were willing to pay up to 10 percent more for it.

An 800 person, nation-wide telephone survey reported by Morris, Rosenfeld and Bellinger in 1993, produced the following results:

- 92 percent expressed concern about health problems caused by pesticides used to grow food (60 per cent were very concerned);
- 95 percent expressed concern about pesticides and fertilizers entering the water supply (71 percent were very concerned);

[17] Winter, Department of Food Science and Technology, University of California, Davis. He cited the survey as Opinion Research Corporation 1990.

- 93 percent expressed concern about the effects of pesticides on the environment (67 percent were very concerned);
- 92 percent believed it to be important for farmers to change their practices by farming primarily with natural methods and using chemicals only as a last resort (60 percent believed it to be very important);
- 94 percent believed it to be important for the government to have stronger policies to reduce the use of chemicals and pesticides in food products.

The authors reported that the degree of 'strong concern' about agrichemicals exceeded that for secondary smoke, air pollution, antibiotic and growth hormone residues in animal products, and is about the same for the risk of severe food poisoning from bacteria in meat.

A 1995 review of surveys, by the Council for Agricultural Science and Technology, confirmed the existence of public concern about pesticide residues in food, but not the extent of that concern. It reported that "approximately one-fourth perceives a great chance of harm from pesticide residues in food whereas approximately the same percentage perceives very little or no chance" (van Ravenswaay 1995, p.1). It also reported that:

- the public generally believed that pests and diseases can be controlled by alternatives to pesticides;
- 'most of the public' was concerned about the effects of pesticides on wildlife and groundwater; there was also concern about farm worker safety;
- market research indicated that 'most consumers' might be willing to pay as much as 5 percent more for guarantees of reduced risk from pesticide residues.

More recently, in 1998, Govindasamy *et al.* of Rutgers, the State University of New Jersey, reported on a number of surveys of consumer attitude to pesticide residues in food. They also applied the logit model of regression analysis to two sets of survey data collected by Rutgers Cooperative Extension, one in 1990, and one in 1997. The combined results of their analysis and their literature review are presented below.

- Food: "Pesticide residues have been repeatedly documented as the leading source of food safety concern among consumers" (p.1).[18] In an ongoing nation-wide survey by the Food Marketing Institute, 73 percent ranked pesticides as their top food safety concern in 1985, with that level of concern increasing each year since then (until at least 1992).[19]

- Environment: "Significant concerns about the pesticide induced external damage to farm workers, groundwater, wildlife, and the environment have also been documented" (p.1).[20]

- Pesticide usage: A 1989 study of four US cities found that 83 percent of respondents were 'risk averse' to pesticide usage.[21] Another 1989 study, this one by Cornell University, found that only 4 percent were unconcerned about the use of chemical pesticides in food production, with 46 percent very concerned, and 50 percent somewhat concerned.[22] In the 1997 Rutgers study, 60 percent of respondents were 'seriously' risk averse to the use of pesticides.

- Age: The effect of age on risk aversion was inconsistent, some studies finding that younger adults were more concerned about pesticide usage,[23] and some finding that they were less concerned.[24]

- Income: In the second Rutgers study risk aversion to pesticides increased with income, and in the first study it decreased. The latter result is more consistent with previous studies.[25]

- Education: The first Rutgers study found that those with higher levels of education were less concerned about pesticides, whilst the second study produced inconclusive results. Previous studies also showed conflicting results—

[18] The authors cited Byrne, Conrado & Toensmeyer 1991; Misra, Huang & Ott 1991; Govindasamy, Italia & Liptak 1997.
[19] Dunlap & Beus 1992.
[20] Weaver, Evans & Luloff 1992.
[21] Zellner & Degner 1989.
[22] Diaz-Knauf, Lopez, Ivankovich, Aguilar, Burgess, Kovach, Petzoldt, Shelton & Tette 1989.
[23] Dunlap & Beus 1992. A survey of the Canadian public by Krewski, Slovic, Bartlett, Flynn & Mertz (1995a) found increased concern about pesticides in food with those under thirty years of age.
[24] The second Rutgers study found that those under the age of thirty-five were 8 percent less likely to be concerned about pesticide residue than those thirty-five or older. This result was consistent with findings reported in Ott 1990.
[25] Byrne *et al.* 1991; Dunlap & Beus 1992.

Dunlap and Beus (1992) found increased aversion with higher education, and Byrne *et al.* (1991) found it decreased.[26]

However, in direct contrast to all the above results, a national survey of consumers' food safety concerns carried out by the University of Kentucky in 1992 found that only 18.4 percent of respondents expressed concern about pesticide residues in food, this concern having slipped to third place behind fats and cholesterol (33 percent), and bacterial food poisoning (30 percent) (Buzby & Skees 1994). The authors considered this ranking to "reflect current scientific evidence which indicates that pesticides pose a lower risk to consumers than does microbial contamination" (Buzby & Skees 1994, p.19). Yet this result is inconsistent with others obtained in the same survey:

- 30 percent believed current levels of pesticides to be safe.[27]
- 31 percent believed Government should ban all pesticides.
- 90 percent wanted clear labelling of food regarding pesticide use so they could make better informed purchasing decisions.
- Over 35 percent grew their own fresh produce to avoid pesticide residues.
- Over 50 percent said that they would prefer to buy organically grown fresh produce, although only 25 percent did so regularly.
- Over 50 percent said they would pay more for pesticide residue-free produce, although only 17.5 percent did so regularly.[28]

In summary, the vast majority of the USA survey results indicate that there is a significant level of public concern about pesticides, both as residues in food and as inputs in agriculture with their ensuing effects on farm workers and the environment. The evidence of the latter is a little thinner simply because so few surveys have asked the questions, most concentrating on food residues. The level of concern in New Zealand would appear to be roughly equivalent to that in the USA. There is also consistent and conclusive evidence from these surveys that women are significantly more concerned about pesticides than are men, that concern apparently increasing with the presence of

[26] Krewski, Slovic, Bartlett, Flynn & Mertz's (1995a) survey of the Canadian public found decreased aversion to pesticide residues with increased education.
[27] The report did not indicate if this was referring to pesticide residues in food or the level of pesticides used by farmers.
[28] The differences between expressed preference and actual purchasing were said, by the authors, to be due to the higher price, lower availability, and lower cosmetic quality of organic produce.

children, a finding that must be reflected in an ethical pesticide policy. Not so consistent or conclusive is the information relating the level of concern to income or age.

2.1.2 Community activities

The limited quantity and nature of the data available from New Zealand attitudinal surveys renders it necessary that other indicators of lay assessment of pesticides be examined. There are a number of possible sources for this, such as public meetings, media reports, petitions, and submissions to regional plans and government proposals. Not all of these will be examined here, for differing reasons. Public meetings and their outcomes have not been well documented. On the other hand media reports abound, as do submissions, but the mere cataloguing of them, it is contended, would not achieve much more than the analysis of the surveys has already. A few general comments regarding media reports will, however, illustrate the nature and extent of interest. Firstly, the release of results of pesticide residue monitoring surveys has generally been accompanied by concerns expressed by consumer and environmental groups on the one hand (e.g. White 1995), and soothing reassurances by government departments on the other (e.g. Pickston & Vannoort 1995, p.2).[29] Secondly, spray drift incidents have also generated a lot of media comment, including TV documentaries. Again, the comment has been dramatically dichotomized, with angry victims on the one hand and on the other, outright denial of the possibility of effect from government authorities and chemical company representatives.[30] Lastly, the discovery of environmental contamination, such as pesticide residues in groundwater, has not generally been made known to the media or the public, so little media comment has occurred.[31] One exception was the release of results from the monitoring of Waikato River water (Sharma 1994), with subsequent public interest revolving around the potential ingestion of pesticide residues if the water is used to supplement Auckland City's drinking water supplies (e.g. McPhee 1994).

The focus of this section is two very structured proactive community initiatives, both of which have involved individual citizens, and community and other public interest groups. Both were supported by petitions. Both were concerned with spray drift. In the

[29] Alison White, Pesticide Action Network Aotearoa New Zealand.
[30] For example the documentary *Rubber Gloves or Green Fingers*, produced by David Jacobs in 1995 and screened on TV One in August 1997.
[31] This statement derives form the author's observation of the situation over a prolonged period, in particular between the years 1991 and the present time. During that time, residues of a number of different pesticides were found in the groundwater in Canterbury (Smith 1993a, 1993b) and in other areas in New Zealand (Close 1993, 1994a, 1994b, 1995a, 1995b, 1996). Media comment was not completely absent, but tended to be localised and low level (e.g. Markby 1993).

first instance a national level coalition of community groups was formed, resulting in the drafting of a piece of legislation, the Agricultural Chemical Trespass Bill. In the second instance, local level community activities to stop a territorial authority spraying roadside weeds in a major urban area resulted in the development of an in-depth policy, the Auckland City Weed Management Policy.

As a final note before further analysis of these two activities, it should be pointed out that although public opposition to pesticide use in New Zealand dates back many years,[32] only very recent community initiatives are reviewed here, for two reasons: the first is the sheer bulk of such activities,[33] and the second is the greater relevance of recent activities to determining current public policy requirements.

Agricultural Chemical Trespass Bill

In October 1995, the Soil & Health Association of New Zealand Inc. initiated a meeting of individuals and community organizations concerned about pesticide spray drift. The objectives of the meeting were:

- To establish goals and methods of dealing with toxic chemical pesticide spray drift problems.
- To establish a campaign for getting chemical trespass and chemical spraydrift legislation through Parliament.
- To co-ordinate anti-pesticide activities.

Wheeler 1995, p.1.

The stimulus for this meeting was the ongoingg problem with the drift of pesticides beyond the property on which they were applied, and the perceived lack of will on the

[32] Opposition to pesticide use in agriculture was first formalised in New Zealand with the establishment of the Humic Compost Club in 1941, now known as the Soil & Health Association of New Zealand Inc. The focus of this group was the countering of the detrimental effect of chemicals, on the agricultural growing system and the food it produced, through the production and use of compost. In 1973 the Initial Volco Trust sought the long term policy of " 'Zero Use of Poisons' " in agriculture, bringing into the debate the externalities of pesticide use, particularly the cost to human health and well-being (Watts 1994, p.12). From the early 1970s the public focus crystallised around the herbicide 2,4,5-T, and a long running public battle to remove this herbicide from New Zealand ensued, a goal finally achieved in 1989. A brief history of public opposition to pesticide use in New Zealand can be found in Watts (1994).

[33] Community initiatives include the 1978 petitioning of the Human Rights Commission to recognize that contamination of soil, air and water is a violation of the United Nations Universal Declaration of Human Rights (Morris 1980); the 1985 public meeting organised by Toxins Awareness Group and attended by 500 people; the tour of New Zealand by Australian activist Dr Kate Short organized by Pesticides Action Network Aotearoa New Zealand; and the 1992 petition in Tauranga that forced the Tauranga City Council to hold a referendum on its own pesticide use (Watts 1994, p.137).

part of government to resolve the problem. Spray drift was a particular issue in rural areas. Many farmers and other rural dwellers had, for a number of years, reported ill health and crop losses as a result of spray drift from aerial application of the herbicide 2,4-D, tractor-mounted boom-spraying of other herbicides, orchard airblast spraying with organophosphate insecticides, and other applications of pesticides (e.g. Peace 1987; Watts 1994b; Sheridan 1995).[34] There were very few legal remedies and very few cases had ever been taken to court successfully.[35]

The outcome of the meeting was the formation of the Chemical Trespass Coalition, the membership of which eventually swelled to thirty-five public interest groups, including community, environmental, farming and health groups. The tasks of the coalition were to achieve a legal prohibition of pesticide spray drift, and the ability to prosecute transgressions. To this end, members of the coalition drafted the Agricultural Chemical Trespass Bill and put the case to Labour MP Jill White (Watts & Reeves 1996). White agreed to promote the Bill through Parliament as a private members bill.

The Agricultural Chemical Trespass Bill seeks to make cross-boundary spray drift an act of trespass, removing the "impractical requirement of proof of adverse effect which is the requirement of the Pesticides Act 1979, the Resource Management Act 1991, and the Health and Safety in Employment Act 1992" (Explanatory Note). It recognises that "the principle of sustainable land management requires that agricultural chemicals are not to be used in a manner which would result in them trespassing onto other land". Its preamble acknowledges the following effects of pesticides:

> . . . human health ill effects which are difficult adequately to ascribe, crop damage, disruption of biologically-based growing systems, loss of organic and biodynamic certification, environmental damage, and the potential for residues in neighbouring crops through failure to comply with required withholding periods.
>
> Agricultural Chemical Trespass Bill 1997, Explanatory Note.

The original drafters of the Bill sought, through this legal mechanism, to establish the moral responsibility of spray users not to drift pesticides, as well as to remove the *de facto* right to drift that had been based partly on the perception of an economic need to so

[34] Margaret Peace (1987) wrote that "we had over 200 people contacting us with stories of plants and health affected by those herbicides" (p.2). She was referring to phenoxy herbicides and to the period of 1979 to 1981.

[35] The only case to succeed under the Pesticides Act is *Attorney General v. Geothermal Produce NZ Ltd 1987*. Cases that have succeeded under other Acts include *Trevor Ivory Ltd v. Anderson 1992* and *Evans v. Harris 1993* (Watts 1994, p.154-7).

do, and partly on the attitude of many spray users that "'I got here first so I can do what I like'" (Watts 1996).

Support for the Bill was then, and appears to remain, significant.[36] A supporting petition, generated by the then Soil & Health Association Vice-President Tim Kivell, has attracted approximately 22,000 signatures. Publicity surrounding the Bill was initially quite intense, and resulted in the common acceptance of the phrase "chemical trespass", which brings with it the notion that spray drift is not acceptable and is indeed trespass on the rights of other people. As mentioned in Chapter 1, when the subsequent drafting of regulations under the HSNO Act 1996 proposed to legalise the drift of pesticides at levels below those established on the basis of mathematical extrapolations from toxicological data, there was a significant outcry from the public, prompting the then Minister for the Environment to retaliate that "its not simply a story of the majority view ruling" (Upton 1998, p.2), as reported in Chapter 1. The Minister did acknowledge that "every New Zealander has the right and opportunity to have his/her say", but concluded that it is 'risk', rather than the view of the public, that should be used to determine how much spray drift should be legally allowed. Here the Minister was referring to technical assessment as the sole determinant of risk. It is contended that public policy *should* reflect the views and values of the public, as well as those of technical risk assessors, and that scientifically derived estimates of risk from pesticides, in fact, lack the validity that is claimed for them by proponents such as Upton. This contention will be substantiated in the next chapter.

Auckland City Weed Management Policy

In a number of urban localities around New Zealand there have been protracted disputes between members of the public and local authorities over the latter's management of weeds along roadsides, and to a lesser extent in parks and reserves. The issue of contention has been the use of chemical herbicides and the resulting exposure of members of the public to low levels of spray drift. Typically, adverse health effects are alleged to have resulted but cannot be proven to occur to the satisfaction of technical experts, hence a stalemate develops, for the local authorities have generally sought

[36] The Bill was drawn from the private members ballot in August 2000, but dropped by its then Labour supporter, Nanaia Mahuta. Labour had, in the interim, been elected to govern the country and had determined to proceed with the regulations being drafted under the HSNO Act. However, apparently in response to the "enormous number of letters" from the public (Marmont 2000), and to the Green MP Ian Ewen-Street's action of putting the Bill back in the ballot under his own name, the new Minister for the Environment, Marian Hobbs, moved to establish a Chemical Trespass Working Group to address the issue (Hobbs 2000).

refuge in the advice of technical experts. That advice has been that the levels of spray drift to which the public might be exposed are too low to cause adverse effects on the average human being, according to results from laboratory trials in which animals are exposed to much higher doses.[37] Therefore, any apparent adverse health effects cannot be caused by the herbicide but instead result probably from anxiety or some other factors. Thus, the councils have rejected the public's concerns, asserting that the herbicides are harmless, and the spraying has continued. However, so too has the conflict between community and council, for those who have been affected by the chemicals do not trust those who deny their interpretation of their own experiences.

Auckland City is one such locality that has experienced this problem. It is chosen for closer examination here partly because the experience has been well documented, and partly because of the manner in which the problem has been resolved through policy development. The actual policy process that was employed will be more closely reviewed in Chapter 7. For now, the issue at hand is that of demonstrating the public attitude. A brief historical overview of the community activities that lead up to the development of the policy is provided in Appendix 1 and summarized here.

Over an eleven-year period from 1986 to 1997, Auckland City Council received more than 156 submissions and seven petitions opposing herbicide use. In addition, there were numerous citizen deputations to meetings, and an unrecorded number of letters and telephone complaints. Whilst there were some submissions in favour of herbicide use, the vast majority on the subject of weed management expressed a desire for the Council to stop using herbicides and to instead adopt non-herbicide methods of vegetation management. The bare bones sketch of this important public activity, provided in Appendix 1, reveals an interesting process of involvement. Many of the Community Committees and Boards responded quite quickly to the concerns expressed by their communities, and in turn expressed these concerns as resolutions, subsequently relaying them to the Council. A number of the Boards passed resolutions that sought non-herbicide weed management in their areas, repeatedly. But those community concerns expressed via, and endorsed by, the Community Boards were not acted upon by the Council or its committees, with the exception of the adoption of a chemical reduction programme in parks in 1994. The larger concern, that of herbicide use on roadsides, was ignored, to the extent that in 1997 the Council's Finance Committee moved to stop all use of non-herbicide methods on streets, in order to save $50,000. The ensuing flood of submissions and petitions resulted finally in the adoption, two years

[37] The problems inherent in this line of reasoning will be come apparent in Chapters 3 and 4.

later, of a non-herbicide policy for street vegetation over the entire city (Davis, Bellingham & Watts 1998). The submissions to the draft annual plan, in which this policy was finally adopted, provided only one opposing voice—that of a farmers' organization, Federated Farmers, who wished to support ongoing use of herbicides in urban areas. The eventual involvement of the community organizations, which had for eleven years engaged with the Council on this issue, in the development of a policy and its subsequent successful adoption, will be visited in Chapters 6 and 7. What is of importance here is the attitude being expressed by the public.

Although accurate statistics are not available for the percentage of the population that prefers that chemical herbicides not be used in populated urban areas, the evidence presented here suggests that that is the mood of the community in New Zealand. If the numbers involved appear small in comparison with the respondents to attitudinal surveys, it must be remembered that to take the initiative of actively submitting to or petitioning a council requires a degree of commitment greatly in excess of that required to fill in a survey form, or to answer questions on a telephone.[38] Therefore, the former exercise should not be judged with a mind attuned to the latter.

2.2 Social rationality: a basis of lay assessment

The technical assessment of risks by scientists is the subject of the next chapter. For now, however it needs to be noted that there is obviously a vast difference between that assessment and the lay assessment as revealed by public opinion and public activities, for after all, the residues and the herbicides that the public have shown concern about have generally been given the regulatory green light, based on risk assessments carried out by scientists. In other words, the pesticides have been deemed to be 'safe', or at least 'acceptable'. Such a view was taken to extremes by Krieger, Ross and Thongsinthusak (1992), in their attempt to make pesticide residues appear to be natural, by referring to them as being so low that they should not be called residues at all, but perhaps "should be regarded as part of our chemical environment" (p.3).[39] It has been demonstrated in this chapter that a significant percentage of the public does not subscribe to that view.

[38] One petition, presented in 1997, contained 6,519 signatures requiring that "Auckland City stop all chemical weed control" (Storer 1997, p.11).
[39] Robert Krieger, Technical Assessment Systems Inc; John Ross and Tian Thongsinthusak, California Environmental Protection Agency, Department of Pesticide Regulation.

Typically, there has been a tendency to regard the public's assessment of technological risk, when it differs from that of the experts, as being irrational or based on ignorance (Kunreuther & Slovic 1996a, p.117). Roger Noll (1996, p.173-4) for example, in the course of his argument in support of greater control by regulatory agencies over the public agenda in risk policy, referred to the public's assessment of risks as resulting variously from incoherence, fear, ignorance and cognitive pathology.[40] Ulrick Beck (1992) noted that there has been a tendency towards the view that the public "need only be stuffed full of technical detail, and then they will share the experts' viewpoint and assessment of the technical manageability of risks, and thus their lack of risk" (p.58).[41] But so far, despite a welter of such risk communication exercises, the public has not been swayed to the experts' point of view. Perhaps this is in part because risk communication has tended to be an act of "persuasive communication", intended to persuade the listener to the correctness of the proponent's point of view and omitting to understand, or to consider, the public's point of view, according to William Leiss (1996, p.89).[42] For those in the social sciences field argue that there is a great deal more to acceptability of risks than meets the eye (Krimsky & Golding 1992a, p.357). A wealth of social relations and worldviews lies behind a person's assessment of the seriousness of an environmental or health issue, all of which influence her or his assessment of that risk.

Many treatises on the subject of risk have delved into the reasons for the differences between the assessments made by the technical experts and by the public, for what lies behind the so-called irrationalities of the public. Some of these are dismissive of the public's assessment, others legitimate it as expressions of social and cultural values. Chauncey Starr was perhaps the first to examine, in his seminal exposition in 1969, some of the factors underlying the differences in assessment.[43] He drew attention to the different acceptability of risks that are voluntary, compared with those that are involuntary, and to the distinctions between catastrophic risks, chronic risks, and natural

[40] Roger Noll, Professor of Public Policy, Department of Economics, Stanford University.
[41] Ulrich Beck, Professor of Sociology, University of Munich.
[42] Leiss held the Eco-Research Chair in Environmental Policy, Queen's University, Kingston, Ontario. His comments related to the period from the mid-eighties to the mid-nineties in North America. It is not certain that this time period translates exactly to the New Zealand context and, in fact, a lag might be likely. Leiss (1996) maintained that risk communication being practiced in North America, at the time he wrote, paid greater attention to social context, including "consensus building" and "meaningful stakeholder interaction" (p.90). This is not currently the approach used in New Zealand: consensus is not generally sort, as various references to pesticide policy have indicated.
[43] Douglas (1985, p.19) dated the emergence of the risk perception debate as 1969 and an article in *Science*, by Starr, entitled "Social benefit versus technological risk". The nuclear energy debate and the stark differences between the perception of risk by the public and by scientists were behind this emerging debate (p.22). However, it was not until 1979 that there was a dramatic escalation in research into risk perception (p.7-9).

hazards. Since then, other writers have emphasized cultural factors (e.g. Douglas 1985; Thompson, Ellis & Wildavsky 1990; Rayner 1992), the importance of benefit on the perception of risk (e.g. Alhakami & Slovic 1994),[44] the issues of trust (e.g. Wynne 1992; Margolis 1996; Slovic 1993, 1997), affect or emotion (e.g. Slovic 1997), controllability (e.g. McDaniels, Axelrod, Cavanagh & Slovic 1997) and habits of mind (Margolis 1996). Some have sought answers to the vexed problem of differing perceptions in psychology, especially through psychometric research (e.g. Fischhoff, Lichtenstein, Slovic, Derby & Keeney 1981). Kristin Shrader-Frechette (1991, p.20) reported that there may even be physiological reasons for differing perceptions of risk.[45] She noted that risk takers have been found to have lower levels of monoamine oxidase, an enzyme "that normally breaks down certain neurotransmitters related to emotion and cognition" (p.20), lower levels of "a brain chemical called DBH", and higher levels of "gonadal hormones" (p.77).[46]

Most of these factors are simply noted here in passing, and will not be elaborated upon, for they have been well explored in other publications, such as those mentioned above. However, there are certain others that are of particular importance in the assessment of pesticides but which have been less visited, and special attention will be paid to these. These factors are trust, habits of mind, socio-cultural factors such as gender, race, worldview, and experience. Experience does not appear in the usual list of factors affecting lay assessment of risks, but it is contended that it has become an important factor where pesticides are concerned. In this instance, the experience referred to is that of adverse health effects resulting from exposure to doses of pesticide that are so low that the technical experts generally deny the possibility of such effects. This is the experience of those people who suffer from multiple chemical sensitivity, a subject that will be scrutinized in detail in Chapter 4. Of the other factors to be reviewed, habits of mind will also be addressed in Chapter 4, for although Margolis used the term primarily in the context of lay assessment, it is contended that this factor exerts at least as much influence on technical assessment as it may do on lay assessment. Trust is an issue of particular importance to pesticide assessment and will be reviewed in this chapter together with some of the cultural factors. One of the main cultural factors however, that of attitude towards nature, will be kept aside until Chapter 5 where it will be analyzed in detail alongside the worldview that underlies scientific rationality.

[44] In which the higher the benefit derived from a risk, the lower the perception of risk associated with it.
[45] Shrader-Frechette, Distinguished Graduate Research Professor, University of South Florida. Philosopher of science.
[46] Shrader-Frechette 1991 (p.190) cited Weiss 1987.

Before embarking on the analysis of trust and socio-cultural factors, a closer look at cultural analysis is merited, for the subject remains controversial. Cultural analysis of risk, according to Steve Rayner (1992) "looks behind the perception of physical risks to the social norms or policies that are being attacked or defended" (p.91).[47] Cultural theorists Thompson, Ellis and Wildavsky (1990) described the perception of risk as "a social process" (p.63).[48] But Shrader-Frechette (1991) rejected, at least in part, the line taken by these 'cultural relativists' for what she saw as their attempt to attribute all risk decisions made by the public to being made solely on the basis of social determinants—she refers to this as "sociological reductionism" (p.37). She rejected this approach because it has been used to undermine the validity of lay assessment, to portray it as irrational, rather than to confirm its rationality. Shrader-Frechette (1991) noted that there are three broad groups of people who have promoted the view that the public's concern about environmental risks, including the carcinogenicity of pesticides, is "biased and irrational" (p.15). These are industry spokespeople, risk assessors, and "a small group of contemporary, antipopulist social scientists" (p.15) including the cultural theorists Douglas (1985), Wildavsky (1988) and Thompson (Thompson, Ellis & Wildavsky 1990). Although they have recognized that technical risk assessment is not value-free, a subject that will be explored in the next chapter, nevertheless they have overemphasized the role of values in lay assessment, according to Shrader-Frechette (1991, p.31). In the process of describing risk as a social construct, they have "singled out environmentalists or sectarian laypersons (in contrast to technical experts) as having particularly biased constructs" (p.31).[49] As a result, she argued, "cultural relativism contributes to a pro-industry bias towards risk, a bias that disenfranchises the lay public and supports the status quo" (p.31). The cultural relativists' claims, that the public are 'superstitious', 'mistrustful', 'anti-science', 'anti-government', 'anti-technology' and 'anti-industry', have been well-addressed by Shrader-Frechette (1991, p.17-26) and will not be revisited here. All that will be noted is her conclusion that these claims are lacking in evidence, confused, based on a "questionable foundation" (p.26), and begging the need for a new theory of rationality. It is contended that whilst the role of cultural values in the assessment of risk by the public may have been used to discredit that assessment, nevertheless those values, and the assessment arising from them *are* legitimate

[47] Rayner, Senior Researcher and Program Manager for Global Environmental Policy Analysis at Battelle, Pacific-Northwest Laboratories in Washington, D.C.

[48] Michael Thompson, Director of the Musgrave Institute, London; Richard Ellis, Assistant Professor of Political Science, Willamette University; Aaron Wildavsky, Professor of Political Science and Public Policy, University of California, Berkeley.

[49] Shrader-Frechette (1991, p.31,234) laid this charge against Douglas and Wildavsky (1982, p.186) in particular. See also Wildavsky (1988, p.1-24).

expressions of social rationality. It will be shown that cultural values play a role in scientific assessment too. How those values found their way into this process will be discussed in Chapter 5.

2.2.1 Loss of trust

Loss of trust is commonly portrayed as mistrust of science. In fact, it may be more correctly framed as mistrust of the way in which scientific results are portrayed and science is used, a mistrust of the institution represented by the expert whether it be the government, the corporates or scientists in general (Wynne 1992, p.277-8).[50] Howard Kunreuther and Paul Slovic (1996b) referred to it as a "lost faith in the ability of science, industry, and government to manage the risks" (p.8).[51] Breyer (1993, p.36) noted that the distrust of experts and the institutions that employ them has been increasing since the mid-1960s. In 1994 Sparks, Shepherd and Frewer also noted the declining levels of trust in experts, referring to society taking on a more egalitarian ethic and to the public becoming increasingly educated in scientific matters as underlying factors in this decline.[52] Sparks and Shepherd, in the same year, noted the declining levels of trust in the competence of regulatory authorities to deal with the hazards associated with food production and consumption. In 1993 Slovic had argued the view that loss of trust in risk managers is a fundamental aspect of the 'conflict' over risk and is the cause of the limited effectiveness of risk 'communication' (p.677), presumably in persuading the public to the experts' views. Restoration of trust will not, by itself, remove this conflict, for other socio-political factors also effect lay assessment. Nevertheless, loss of trust is a powerful force in the refusal of the public to be persuaded by the experts' views with respect to pesticides. Therefore, a brief analysis of those aspects particularly pertinent to pesticides follows.

The DDT Saga

The loss of trust stems, in part, from proven failures of expert risk assessment. In particular, it remains as a legacy of the DDT saga. The historical fiasco of the scientific/political approval of the use of DDT via pesticide registration systems, its

[50] Also noted by Freudenburg 1996, p.51.
[51] Kunreuther, Professor of Decision Sciences and Public Policy, University of Pennsylvania; Slovic, see Chpt 1, fn32.
[52] Paul Sparks, social psychologist; Richard Shepherd, Head of Food Choice Section of the Consumer Sciences Department; Lynn Frewer, a psychologist—all at the Institute of Food Research, Reading, UK. They cited Barber 1983.

ensuing widespread use and subsequent withdrawal because of environmental persistence, has resulted not only in a legacy of contamination twenty or more years after its use ceased in most countries, but also in a legacy of mistrust of scientific processes where pesticides are concerned—in the minds at least of some sectors of the public who are cognisant of the history. DDT was first synthesized in Strasbourg in 1874. A young chemistry student Paul Müller at the J.R. Geigy laboratories in Basel discovered its insecticidal properties against the Colorado potato beetle in 1939 (Whorton 1974, p.248; Wildavsky 1995, p.55-6). Following successful trials in the USA in 1942, all available stocks of the insecticide were immediately appropriated by the US Army for combating lice in Europe and mosquitoes in the Pacific. Its use on civilian populations to quell insect-borne epidemics was widespread, with the insecticide "being used so freely as even to replace rice at weddings" (Whorton 1974, p.248). It became available for widespread commercial use in US agriculture in 1945 (Biskind 1953, p.331), and first appeared in New Zealand shortly after. According to Aaron Wildavsky (1995, p.56), the first environmental problems were noted as early as 1944, in the form of toxicity to fish and frogs.[53] By 1945 scientists knew that DDT accumulated in the body fat and milk of laboratory animals. Warnings of adverse human health impacts soon began appearing. New York physician Dr Morton Biskind reported, in 1953, that by 1950 the United States government had begun to recognize the human health implications of DDT. The United States Federal Food and Drug Administration (US FDA) announced that:

> The finding of hepatic cell alteration at dietary levels as low as 5 p.p.m. of DDT, and the considerable storage of the chemical at levels that might occur in some human diets, makes it extremely likely that the potential hazard of DDT has been underestimated.
>
> Laug *et al.* 1950, cited in Biskind 1953, p.331.54

In 1951 the United States Public Health Service acknowledged that:

> Due to the fact that DDT accumulates in the body tissues, especially in females, the repeated inhalation or ingestion of DDT constitutes a distinct health hazard. The deleterious effects are manifested principally in the liver, spleen, kidneys and spinal cord.
>
> English 1951, cited in Biskind 1953, p.331.

[53] Wildavsky, Professor of Political Science and Public Policy, University of California, Berkeley.
[54] Wildavsky (1995, p.56) sought to discredit Biskind by stating that his 1949 article, in which Biskind had claimed that DDT was linked to a mysterious virus X in the human body (Biskind 1949), was refuted in an article in the July 1949 edition of *Science Digest* 26:47, entitled "DDT danger refuted". No name was provided for the author, or the rationale for the refutation.

In 1962 scientist Rachel Carson published her book *Silent Spring*, providing compelling evidence of the environmental effects of DDT, especially on the survival of bird species.[55] In January 1968 the state of Arizona imposed an experimental one-year ban (Wildavsky 1995, p.57), but the first country to totally ban DDT was Hungary, in 1969. The USA followed suit in 1972 (Watts 1994).

However, it was not until 1989 that New Zealand banned DDT, thirty-nine years after the first health warnings, twenty-six years after the environmental warnings, and twenty years after the first country took heed of those warnings. DDT had been used extensively for controlling grass-grub in pastures between 1950 and 1970. In a move to protect its export markets, and hence its economy, New Zealand had prohibited the use of DDT in agriculture in 1970.[56] However, since health and environmental effects were not proven beyond doubt, all other uses of DDT were allowed to continue: in orchards and on horticultural crops, sports fields, home gardens, and aerodromes (Bingham 1992). Finally, in 1989, DDT was banned for all uses in New Zealand.

It is widely acknowledged now that expert opinion failed the public with respect to DDT:

> When we consider failures of expert opinion on risk, DDT being an obvious example, it is important to recognize that in defining risk narrowly to include only human health, most experts failed to anticipate the more important risk: environmental toxicity.
>
> Peterson & Higley 1993, p.207.

Of course, there is not a unanimous voice on this:

> There is no getting away from it: completely banning DDT did more harm than good.
>
> Wildavsky 1995, p.79.

Expert disagreement

When experts disagree amongst themselves about the assessment of risks from pesticides, there is even less room for public confidence in the view put forward by

[55] The version of *Silent Spring* used in this thesis is the 1965 publication by Penguin.

[56] The export market protection was sought through reduction of residues in food. Such was the scale of use, and the problem with persistence in body fat that, as recently as the late 1980s/early 1990s, almost 40 percent of Canterbury lamb samples contained residues of DDT above the European Union's permitted residue limit of 1 part per million following a drought period (Bingham 1992). The New Zealand government has attempted to persuade Codex to institute a maximum allowable residue level of 5mg/kg, against the Europeans' determination to have it lowered from 3 to 1mg/kg (Lunn & Jolly 1999).

government regulators. One example of such conflict between experts is provided by the finding, in several studies, that there is significant disagreement amongst toxicologists about the value of animal studies in predicting risk to humans.[57] Table 2.2 provides a selection of results from one of these surveys, the striking feature of which is that nearly 50 percent of toxicologists surveyed believed that reactions by animals to chemicals are not accurate predictors of reactions by humans. If toxicologists have so little apparent faith in their own work, and disagree to this extent about whether or not the animal studies do in fact accurately predict risks to humans, then it is difficult to understand why the public should be expected to trust the assessments of risk to humans that flow from their work.

Table 2.2 Views of toxicologists on the value of animal studies in predicting risks to humans

Statement	% yes	% no	?
Animal reactions to a chemical are a reliable predictor of human reaction.	48.1	48.7	3.2
Studies overestimate risk of cancer in humans because of the cytotoxic effect of high doses.	85.5	10.6	3.8
Studies overestimate risk of cancer in humans because the animals are cancer-prone.	49.7	42.3	8.0
Studies underestimate risk to humans because of > human genetic diversity.	33.3	51.6	15.1
Studies underestimate risk to humans because of synergistic effects of chemical mixtures.	40.7	38.5	20.8

Source: Slovic *et al.*1997, p.296.

Robert Peterson and Leon Higley (1993) noted that "the public realizes that experts can be found to support any position in a risk argument because attitudes about risk are inherently subjective" (p.208).[58] Dale Jamieson (1996), in referring to this "spectacle of duelling experts", concluded that "rather than providing a rational means for resolving epistemological differences, uncertainty reduces science to just another playground for

[57] Kraus, Malmfors, & Slovic 1992; Slovic, Malmfors, Krewski, Mertz, Neil & Bartlett 1995; Slovic, Malmfors, Mertz, Neil & Purchase 1997. Chapter 3 will reveal the extent to which the assessment of risk to human health is based on the effects of pesticides on animals.

[58] Peterson, graduate research assistant, and Higley, Associate Professor: Department of Entomology, University of Nebraska-Lincoln. This pointed was also made by Kunreuther & Slovic 1996b (p.8).

competing ideologies" (p.40).[59] It is contended, therefore, that the public have no choice but to fall back on their own intuitive assessment, or on those of the groups they most trust and with whom they share a common ideology. Experience, such as with DDT, has taught them not to trust the government or industry assessors. With that experience comes a dread of future consequences, of the possibility of delayed effects such as cancer. For, as Peterson and Higley (1993) pointed out, "the public knows that experts have advocated the use of pesticides without full knowledge of their potential hazards" (p.208). Catastrophic events like the Bhopal explosion also breed mistrust, for the public comes to realize that risks such as these are seldom incorporated into the experts' predictions of risk (Peterson & Higley 1993, p.208).

Lack of data

When public concern erupts over a cluster of health effects that are attributed to a particular pesticide, investigations are carried out, and the results are generally portrayed as 'there being no evidence that the pesticide caused the birth defects', for example. The institution or media presenting this material to the public generally infers that 'therefore the pesticide did not cause the birth defects'. But that is not what the science said, for science is incapable of determining that, and it is contended that the public understands that, at least intuitively. The result is a feeling of being hoodwinked. That science may be incapable of determining exactly what it is that the public want to know is well recognized by some scientists (e.g. Gots 1993, p.95,132; Ottoboni 1984, p.179), but this problem is seldom acknowledged publicly. Instead of the public being told that 'we don't know the answers to this yet', they are told that 'there is no evidence that an effect is occurring', or 'the best available data' is such and such.

Whilst Ronald Gots (1993) acknowledged that "for many chemicals we simply had little or no data" (p.95), the regulators did not, and generally still do not, make such acknowledgements of omission.[60] Beck (1992) noted the pressure on technology of the "unbearable burden of infallibility" (p.177):

> As risks multiply, the pressure grows to pass oneself off as infallible and thereby deprive oneself of the ability to learn. The most self-evident thing, the admission of human failure, then coincides with causing catastrophes and must be avoided by all means.
>
> Beck 1992, p.177.

[59] Jamieson, Professor of Philosophy, University of Colorado, Boulder, and adjunct scientist in the Environmental and Societal Impacts Group at the National Centre for Atmospheric Research, USA.
[60] Gots, National Medical Advisory Service, Bethesda, Maryland, USA.

When the passage of time proves, through experience and improved scientific knowledge, that some of those chemicals do indeed cause the effects feared by the public, the regulators do not acknowledge that the public was right and they were wrong, for they have become ensnared in the trap of their own making—they have condemned themselves to perfection, as Beck would have it (1992, p.177). But the public sense the fallibility, and so the mistrust is proven to have been well placed and hence becomes ever more strongly cemented into place.

Recurring events in which the regulators find new adverse effects caused by particular pesticides also generates a degree of mistrust in those institutions. For example, when the public are repeatedly reassured that there is no significant risk attached to the aerial application of 1080 poison in New Zealand native bush areas for possum control, and then several years later they are informed that new toxicological data shows teratogenicity in rats, then the public mistrust deepens.[61] Accompanying reassurances that the levels found are still well short of those that are likely to cause adverse effects fall on deaf ears. What has been heard is that the public assessment, that there is unacceptable risk, has been confirmed and that the scientists were wrong, although there is no admission of error on the part of the latter and their current view comes wrapped in the same reassurances that wrapped the initial lack of knowledge of effects. As Slovic (1997) noted, "trust is fragile . . . typically created rather slowly, but it can be destroyed in an instant" (p.88).

It is, in part, this lack of trust in the institution of pesticide regulation that results in the selective acceptance of the results of scientific research, noted by Slovic (1997, p.93), allowing the acceptance of a single study revealing a link between a chemical and adverse health effects where numerous other studies have failed to find such a link. The intuitive application of the precautionary approach gives emphasis to the effects of mistrust: if there is any doubt at all about a pesticide's safety, or even the slimmest evidence that there might be potential harm, then the public's sense of mistrust is heightened.

What else don't they know?

> Experience tells us that new unexpected forms of toxicity may be uncovered in the future.
>
> Chemicals Policy Committee 1997, p.12.

[61] Information sourced from a newspaper report that has not been traced. However, Dr Natalia Foronda of the Ministry of Health confirmed by telephone the toxicological finding. 2000 Dec 14.

Unknown as a possible effect of pesticides until very recently, at least to the general public, endocrine disruption has increasingly become a focus for concern with reports of lowered human sperm counts, more female babies than male babies being born, and shrunken penises in crocodiles.[62] Whilst this issue increasingly occupies the public mind, the toxicologist for New Zealand's Pesticide Board, John Reeve, has been very dismissive of such effects (Reeve 1997). Therefore, no matter how safe the Board may declare a pesticide to be, the fact that it has not been specifically screened for endocrine disruption is likely to leave the public with little faith in the technical assessment of risk. A similar situation exists for multiple chemical sensitivity: where members of the public experience such effects and that view is supported by their medical support person, yet it is discredited by the scientists who carry out the technical assessment, then again the public will have little reason to accept the technical risk assessment. This special case will be reviewed in depth in Chapter 4.

The emergence of endocrine disruption as an issue of pesticide use has tended to heighten the public view that possibly all potential effects of pesticides are not known to the scientists: will more adverse effects emerge in the future, about which we currently have no understanding? William Freudenburg (1996) noted the danger of "unknown unknowns": blind spots that not only do we fail to see, but that "we fail to see that we fail to see" (p.49).[63] With a history of uncomfortable surprises being visited upon society sometime after a technology has become mainstream, such as the persistence of DDT and more recently endocrine disruption, the public has become more aware of the 'unknown unknowns', and less willing to accept risk statements without asking 'What else lurks unforeseen?'.

Confidence, control, and accountability

There is another issue relating to trust, one that is quite separate from the track record of science and resultant public suspicion—and that is to do with confidence and self-confidence. A decision-maker, according to Luhmann (1993), "has the possibility of taking into account his [*sic*] expertise, his self-confidence and his collateral when making his decision" (p.113). However, the recipient of someone else's decision "has to be content with believing that the others will keep the situation under control" (p.113). Such blind faith does not come easily to many people, yet it lies at the heart of modern

[62] This issue will be raised again in Chapter 3 and discussed at length in Chapter 6, with references provided there.
[63] Professor Freudenburg, Department of Rural Sociology, University of Wisconsin, Madison, Wisconsin, USA.

technocratic society. Where uncertainty about subtle risks is high, as with chemical technologies, that faith becomes sorely tested, and "confidence in the self-confidence of others evaporates" (Luhmann 1993, p.14).

Somewhat allied to the issue of confidence is that of control. It is contended that the loss of social control that has accompanied the increase in technological control, noted by Freudenburg (1996, p.46), plays a significant role in the loss of trust in the institutions of concern here, namely government and its regulators and bureaucrats. Technological control resides essentially with those who develop, market and own the technology—in the case of pesticides these are primarily the transnational chemical corporations. That control is mediated by the government and, as society becomes more and more technologized, the societal response to its loss of control becomes reflected in its lessening trust in the organizations and institutions involved. Peterson and Higley (1993, p.207) also referred to the issue of control, but more specifically to the inability to control the level of residues ingested in food in comparison with the ability to control other risks such as smoking, or even the ingestion of foods that are known carcinogens. What cannot be controlled is less likely to be trusted.

Trust is also likely to be affected by the extent to which decision-makers will be/are held accountable for their decisions. Where it is evident that there is no relationship between the consequences of a risky decision and those responsible for making that decision, trust is likely to diminish. In a bureaucracy that proscribes and regulates the use of pesticides, it is often impossible to pinpoint individual onus, especially as the passage of time between cause and recognition of effect blurs the line of responsibility.[64] Even if such a line of responsibility can be established the decision-maker is frequently protected by law from the necessity of taking responsibility for her/his/their decisions. The Pesticide Board as a statutory authority has no legal accountability for any adverse health or environmental effects resulting from registered pesticides. The provider of the risky chemical, the pesticide company, is also frequently absolved of liability. The end result, where neither regulator nor corporate provider is responsible for the outcome, is what has been referred to by the Minister for the Environment Simon Upton as 'the socialising of risk': society pays the price if the potential hazard is realized, it pays the cost whilst some corporates and/or individuals reap the benefits.[65] Sheeting home the costs to the benefit takers might better foster trust.

[64] Even assuming that such cause and effect can be proven to the satisfaction of the law courts, given the numerous other extraneous contributing factors that could be involved in ill-health.
[65] The expression was used in the oral version of Upton's opening address to the ERMA conference in June 1999, Wellington; it was not included in the subsequently released written version.

Diversionary reframing

It is contended that what Freudenburg (1996) referred to as "diversionary reframing" (p.51) also engenders a loss of trust. This technique is employed to discredit citizens who oppose a particular technology by referring to them as opposed to science, thereby diverting attention away from legitimate concerns about the particular technology and allowing politicians to side with science in general. Such diversionary reframing is common in the pesticides debate, and has also been used in a more generalist sense by some of the cultural theorists, according to Shrader-Frechette, to undermine the validity of social rationality. As noted earlier in this chapter, Shrader-Frechette (1991, p.17-26) reported the following descriptions by cultural relativists of the public: 'anti-science', 'anti-government', 'anti-technology' and 'anti-industry'.

It is contended that the effect of such diversionary reframing, in which lay assessment of pesticides is reframed as chemophobia or anti-science (Shrader-Frechette 1997, p.107), on a person who knows what it is that she/he believes is to merely further entrench the mistrust that already exists.

Gender

Trust may also be an issue of gender: Slovic *et al.* (1997, p.300) reported that, in one survey, men exhibited more trust in the accuracy of experts' estimations of health risks from chemicals in the environment than did women. As has already been shown, gender has a significant effect on lay assessment, with women being significantly more concerned about pesticide risks than men.[66] Similar gender differences will also be demonstrated, in section 2.2.2, as underlying other factors that effect assessment of pesticides, by both lay assessors and technical assessors.

Propaganda

A recently emerging issue of trust is that of the impact of the propaganda supporting the world-wide introduction of gene technology, and it is contended that propaganda will have a profoundly adverse effect on trust with respect to pesticides, greater even than that of the DDT history. The supporters of the genetic engineering of agricultural crops

[66] The same gender differences have been reported with respect to lay assessment of genetic engineering. Sparks *et al.* (1994), reporting on a UK survey of attitudes, noted that "compared to men, women indicated less need for the technology, gave lower ratings about improvements to the quality of life, reported lower benefits and greater risks, expressed less favourable attitudes to all three applications [animal, plant and microorganisms], expressed greater concern, and agreed more strongly that ethical issues were involved" (p.25).

have, as one of their main messages, hailed the advantage of the technology in reducing pesticide use. This message is being promoted by those same institutions that have for decades promoted the use of pesticides: science, government and corporates (e.g. Gardiner 2000, p.4). The obvious inference to be drawn from this, by the public, is an acknowledgement by the proponents of pesticides that these chemicals were not such a good idea after all. When that message even comes directly from pesticide manufacturing corporations, trust must hit an all time low. The following comment was delivered by James Zarndt, one of Monsanto's commercial team leaders, to a four-day annual meeting of the Specialty Coffee Association of America:

> At the present time [coffee growers] are using pretty significant chemical solutions such as fungicides and insecticides but one has to wonder if these are sustainable practices. There are potential solutions in the area of insect control in particular that biotechnology may be able to provide.
>
> Reuters 1999.

In summary, many writers have identified what Kunreuther and Slovic (1996b) referred to it as a "lost faith in the ability of science, industry, and government to manage the risks" (p.8). These are the institutions that administer pesticides. The loss of faith stems, in part, from proven failures of expert risk assessment, and in part also from a refusal by those institutions to admit to less than perfection, either in terms of such errors or a lack of knowledge. Other factors that diminish trust have also been identified. These include disagreement amongst experts, a tendency to portray a lack of knowledge as a lack of adverse effect, recurrent lowering of permitted residue levels and/or banning of pesticides previously deemed safe, the intuitive application of the precautionary principle by the public in areas of uncertainty and subtle risk, the difficulty of having confidence in the self-confidence of others, a loss of social control, the diversionary re-framing that occurs when the lay assessor is accused of being anti-science, and a lack of accountability for the decisions made by bureaucratic regulators. Gender has a significant effect on trust too, just as it has also been shown to effect assessment of risk from pesticides.

Who is trusted?

It has been posited that a lack of trust is one of the underlying reasons for differences in the assessment of pesticide risks by members of the public on the one hand, and by technical experts on the other. The preceding section has illustrated many of the reasons for this mistrust. This section will seek to establish the existence of that mistrust, who is not trusted and who might instead be entrusted to make pesticide registration decisions.

Frewer, Howard, Hedderley and Shepherd (1996, p.473) concluded that, with respect to food safety issues, the public often distrust industry and the government and are more inclined to trust consumer organizations, "quality" media, and medical doctors.[67] It is important to ascertain if this is the case specifically with pesticides and specifically in New Zealand, since that is the subject at hand. Unfortunately, there is very little New Zealand survey material available to assist with this, so again recourse must be had to international literature, and to biotechnology material, to provide some depth to the evidence.

New Zealand

Wilson-Salt's (1996) survey on attitudes about pesticide residues in food found that most trust was had in public interest groups and the Department of Health.[68] Agrichemical companies and producer groups were the least trusted—refer table 2.3.

Table 2.3 Trust in sources of information on pesticide residues in food

Source	% reliable
Public interest groups	30
Department of Health	28
Government research agencies	16
University scientists	9
News media	6
Environmental groups	5
Producer groups	1
Agrichemical companies	1

Source: Wilson-Salt 1996, p.53.

The second New Zealand survey of relevance here is the 1997 New Zealand Eurobarometer biotechnology survey, which tested attitudes to genetic engineering and compared them with those obtained in a number of other countries (Macer 1998)—refer Table 2.4.[69] The results indicated that most trust was placed in university and research institutes, closely followed by consumer organizations, and then by environmental organizations. The conclusion that can be drawn from these results is that politicians,

[67] Institute of Food Research, Reading, U.K.
[68] Now Ministry of Health.
[69] This survey was carried out by random telephone number selection with responses obtained for every area of New Zealand. The number of respondents was 508, of which 58% were female, and the mean age was forty-five years. There was no indication of what percentage of the respondents were Maori, which is of importance in considering the level of trust in Maori groups.

public authorities and the industry were not trusted to tell the truth. In contrast, far greater trust was placed in academics, researchers, and consumer and environmental organizations. Interestingly, also, the medical profession was significantly more trusted to tell the truth about genetically modified field crops than were farmers. The other point of interest is that, in a comparison with the results from Japan, New Zealanders were much more trusting of researchers and academics than were their Asian neighbours. A similar level of trust was placed in consumer and environmental organizations. It must be noted that this survey is about biotechnology, a subject about which many New Zealanders knew very little in 1997. In contrast, many more New Zealanders will have been aware of the contentious aspects of pesticide use. It is contended that where public knowledge about a highly technical field is limited, greater trust may be placed in academics and researchers than would be the case with a technology with which the public has had much greater experience over a longer period of time. Therefore, it is possible that the public's level of trust in academics and researchers may be less for issues related to pesticides than that demonstrated with respect to biotechnology.

Table 2.4 Levels of trust by New Zealanders in various organizations

	1 (%)	2 (%)	3 (%)
Universities/research institutes	81	54	81
Consumer groups	79	47	78
Environmental groups	66	23	71
Animal welfare groups	50	7	33
Public authorities	37	5	32
Religious groups	20	3	14
Industry	19	1	20
Maori groups	18	1	15
Trade unions	10	0	-
Political parties	5	0	4
Farmers groups	-	-	38
Medical profession	-	-	59
Media	-	-	31

1 = confidence in these sources of information about biotechnology
2 = most confidence in to tell the truth
3 = confidence in to tell the truth about new genetically modified food crops grown in fields.
- = not listed in questions.

Source: Macer 1998, p.2-3.

Other countries

A review of surveys of the US public with respect to lay assessment of pesticides found that "the majority of the public does not trust government to set or enforce safety standards", and that "public opinion is split over whether the scientific community truthfully represents the health risks from pesticides" (van Ravenswaay 1995, p.27).

In 1996 the *New Scientist* reported the findings of a survey in which people were required to identify those whom they most and least trusted. Of the ten groups of people or organizations identified, the government were the least trusted, companies the next least trusted and scientists ranked sixth, two places behind environmental groups, in whom trust was exceeded only by that placed in family and friends (Marris & Langford 1996).

A survey of the Canadian public in 1992, about the sources from which they obtained information, revealed that respondents had the greatest confidence in medical doctors and the least confidence in private industry (Krewski *et al*. 1995a, 1995b). The same survey revealed that only 38.8 percent believed that decisions about health risks should be left to the experts (Krewski *et al.* 1995b, p.241).[70] Public interest and environmental groups received a lower degree of trust than has been found in some surveys, lower than government ministries and the media, but higher than provincial and municipal government, and very similar to university scientists (Krewski *et al.* 1995a, p.128).[71]

In 1994, Sparks *et al.* reported on a survey of randomly selected members of the UK general public about attitudes towards gene technology.[72] Although not directly applicable to pesticides, the results nevertheless can be seen as being indicative of a general attitude towards technological issues. In prefacing the results of this survey, the authors referred to "the assertion by Thompson [1987] that activists (in the biotechnology debate) will be seen as more trustworthy because their positions are less clearly influenced by self-interest than are those of 'scientific proponents' of the technology" (Sparks *et al.* 1994, p.21). They referred also to other research in the biotechnology area "that indicates low levels of trust in industry and political organizations and higher

[70] This survey was not about pesticides in particular but did place significant focus on risks from chemicals in general.
[71] Exact percentages are not given and it is therefore not possible to precisely order these groups.
[72] 6000 selected, 1499 responses.

levels of trust in environmental and consumer organizations" (p.21).[73] Such also were the findings of Sparks *et al.* (1994). In answer to the question "How likely would you be to believe statements made about the benefits and risks of biotechnology made by the following?", the mean result showed most trust was placed in the Consumers' Association, followed closely by a TV current affairs programme, Greenpeace and Friends of the Earth. Least trusted of all were government ministers. Neither scientists nor industry were included in the question.

However, a US survey about attitudes to biotechnology produced results that are strikingly different to all others that have been reported. Thomas Hoban (1996, p.6,8) stated that a 1994 survey on behalf of Grocery Manufacturers of America (Hoban 1994) found that the most trusted sources of information were independent scientific organizations and government agencies, and the less trusted were food manufactures, grocery stores and activist groups.[74] Moderate trust ratings were accorded farmers, media and biotechnology companies.

Table 2.5 provides an overview of the results from the surveys described, expressed as relative rankings. Not all the surveys included questions about the same organizations, so some figures are missing. The overview should be regarded as approximate only, but sufficient to provide some general sense of the situation.

Table 2.5 Summary of trust in organizations, expressed as comparative rankings, where 1 is most trusted and 7 least trusted

Organization	Survey						
	a	b	c	d	e	f	mean
Medical professionals	-	4	-	1	-	-	2.5
Consumer/public interest groups	1	2	-	4	1	7	3
Researchers	3	1	5	6	-	1	3.2
Government	2	5	7	2	5	1	3.7
Environmental groups	5	3	2	4	3	7	4
Media	4	6	-	3	2	4	4
Pesticide/biotech companies	6	7	6	7	-	4	6

a=Wilson-Salt 1996; b=Macer 1998; c=Marris & Langford 1996; d=Krewski *et al.* 1995a, 1995b; e=Sparks *et al*. 1994; f=Hoban 1996.

[73] Marlier 1992.

[74] Professor Hoban, Departments of Sociology and Anthropology, and Food Science, North Carolina State University, Raleigh.

In summary, the majority of the available evidence indicates that industry experts and government are the two least trusted of organizations with respect to risk assessment of pesticides, although this may differ from country to country. Yet it is precisely these two organizations with which the risk management decisions currently rest, the government and bureaucracy as decision-makers, and the pesticide industry as generators of the information upon which the decisions are based. Although the results presented here are not consistent, there can be gleaned a tendency towards a greater trust in public interest groups than in the usual decision-making duo of government and industry. Slovic (1997, p.91) noted that, in another survey, the only event to substantially increase trust was the significant inclusion of local citizens and environmentalists in the decision-making process. Such a conclusion has important ramifications in the constitution of the policy making team if an ethical policy that is acceptable to the public is to be established:

> To be trusted, information must be provided by sources which are not seen as biased or self-serving. If the public believe governments work closely with industry, which may be seen as possessing a vested interest in putting forward a particular view, trust in regulation and legislative controls may be reduced.
>
> Frewer *et al*. 1996, p.474.

2.2.2 Other social and cultural influences

It is contended that there is no basis for assuming that lay assessment of risks from pesticides is any more biased or irrational than that of technical assessment, but that it merely reflects the values of those people who make the assessments, in the same way that technical assessment reflects the values of the current scientific/technical paradigm.[75] The contention that values play an important role in technical risk assessment is well supported by the literature.[76] This role will be demonstrated with respect to the technical assessment of pesticides in Chapter 3. Chapter 5 will demonstrate how a particular social perspective influenced the development of science and hence the rationality that is claimed by it. The formative factors of that particular

[75] "A paradigm is a shorthand description of the world view, the collection of values, beliefs, habits, and norms which form the frame of reference of a collectivity of people—those who share a nation, a religion, a social class. According to one writer, a dominant social paradigm is the mental image of social reality that guides expectations in a society" (Devall 1980, p.126).

[76] See, for example, Shrader-Frechette 1985, 1991; Gough 1990; Mayo & Hollander 1991; Krimsky & Golding 1992b; Cothern 1996; Kunreuther & Slovic 1996a; Keeney 1996; Slovic 1997; Brunk *et al*. 1998.

social perspective also exert an important, but differing, influence on lay assessment. There are gender, social status and worldview effects. A brief review of the literature pertaining to these factors and their influence on lay assessment will be presented here.

Gender

During the 1990s, a series of studies was carried out by Paul Slovic and colleagues into the effects of gender on lay assessment of risk. The studies consistently revealed that for a variety of health and environmental risks, including those posed by nuclear and chemical technologies, the level of risk was assessed to be higher by women than by men (e.g. Flynn, Slovic & Mertz 1994;[77] Kraus *et al.* 1992; Krewski *et al.* 1995b[78]). The only exception to this was a finding by Flynn *et al.* (1994) that for non-white Americans there was no significant difference between men and women in the assessment of risks relating to nuclear and chemical technologies.

These findings are well supported by the New Zealand and USA attitudinal surveys relating to pesticides, genetic engineering and general environmental attitudes reported already in this chapter. In New Zealand, the Lifestyle and Environment Survey (Colmar Brunton Research 1993) found that most concern about pesticides was shown by women aged between 30-39 (51 percent compared to 44 percent for all respondents). Women were more likely to eat organic food,[79] and to use natural pesticides.[80] They also dominated the 'deep green' segment of environmental attitudes (70 percent). In a survey of the general public, Paul Couchman and Kenneth Fink-Jensen (1990, p.24,27,29,37,38) found a consistent difference in attitude to genetic engineering by men and women. In answer to every relevant question in the survey, women assessed the risks as higher than did men (49 to 37 percent; 54 to 43 percent), and correspondingly the acceptability and benefits as lower (53 to 61 percent; 48 to 64 percent; 61 to 71 percent). Again, in 2000, a survey of the New Zealand public's views on biotechnology reported that "women consistently found the technology less acceptable than men, identified more risks, and fewer benefits, and were more inclined to have moral concerns (Gamble, Muggleston, Hedderley, Parminter & Richardson-Harman 2000, p.43).

[77] Flynn *et al.* (1994, p.1101) cited a number of supportive studies relating to nuclear energy, waste, war, smoking, drugs, driving, and also the following of a more relevant nature: Pillisuk & Acredolo 1988; Steger & Witte 1989; Gutteling & Wiegman 1993; Slovic, Flynn, Mertz & Mullican 1993; Stern, Dietz & Kalof 1993.

[78] Krewski *et al.* (1995a, p.130) cited the following supportive studies: Slovic, Fischhoff & Lichtenstein 1982; Buss, Craik & Dake 1986; Dake 1991.

[79] 27 percent of women aged 30-39 compared with 19 percent of all respondents.

[80] 32 percent of women aged 40+ compared with 21 percent of all respondents.

In the USA, Govindasamy *et al.* (1998) found that women were 14 percent more likely to be risk averse to pesticide usage than men,[81] that men chose chemical pesticides over non-chemical pesticides more often than women,[82] and that having children resulted in an increased concern about pesticides.[83] A survey of members of the public in Australia found, once again, that concern for the environment was higher amongst females than males. Carolyn Merchant (1996) reported that 54 percent of women were concerned about pollution compared with 46 percent of men, 53 percent to 47 percent about nature conservation, and 42 percent to 29 percent about "social and environmental issues" (p.189).[84] Men were more concerned about economic issues (61 percent to 48 percent).[85]

This assessment of greater risk by women is consistent with what Barke, Jenkins-Smith and Slovic (1997, p.168) referred to as women's leadership in political efforts to reduce health and environmental risks.[86] Mary Joy Breton (1998) traced this leadership back to the 12th century and the German nun, writer, artist and mystic, Hildegard of Bingen, who "forewarned about the ecological peril now facing the earth" (p.xi). In early twentieth century USA, middle-class women were a powerful force in the 'progressive conservation crusade', saving many old forests from the "men whose souls are gang-saws" as they were described by Mrs Robert Burdett, President of the California Federation of Women's Clubs in 1900 (Merchant 1996, p.111). Women have been prominent in tree-saving movements around the world, movements such as the Chipko movement of India (Shiva 1989, p.67-77) and the Greenbelt movement of Kenya founded by Wangari Maathai in 1977 (Breton 1998, p.11). The Chipko movement began in Rajasthan three hundred years ago when, first Amrita Devi and then each of her three daughters, sacrificed their lives before the axes of the Maharajah of Jodphur's men, rather than let them chop down the forests that were so vital to the survival of the villages. By the end of the day over 350 women and men had been killed (Breton 1998, p.3).

But it is women's involvement in the movement to curtail the risks from chemical technology that is most striking (Merchant 1996, p.12). The movement is noted, not only for its bold thinkers and outspoken leaders such as Rachel Carson (1965) and Theo

[81] This result was supported by previous studies by Penner, Kramer & Frantz 1985; Byrne *et al.* 1991; Dunlap & Beus 1992; Huang 1993.
[82] In a survey of homeowners and gardeners (Grieshop, Stiles & Bone 1989).
[83] Supported by Diaz-Knauf *et al.* 1995 (full citation not provided), and Bruhn, Peterson, Philips & Sakovidh 1992. In the first Rutgers study this increase amounted to 11 percent.
[84] Merchant, University of California, Berkeley, USA.
[85] Merchant cited Brown & Switzer 1991.
[86] Barke *et al.* (1997) and Merchant (1996, p.11) both cited as supporting evidence Nelkin 1981.

Colborn (1996), but also for its grassroots activists. During the 1980s, in the USA, 80-85 percent of grass root activists in the 'antitoxic movement' were women, according to Merchant (1996, p.160). Nicholas Low and Brendan Gleeson (1998) also noted that "women have been at the forefront of the struggle against the injustice of toxified local environments and the degradation of the planetary ecology" (p.42).[87] So did Andrew Dobson (1998, p.21).[88] "Why do women do it?" asked Kate Short of the Total Environment Centre in Sydney:

> Because nobody else will! . . . . Because they perceive the risk more keenly than their men and because they are so often the doers of the community.
>
> Short 1992, p.508.

> Because they bear children and they and their children bear the consequences. Their wombs and their breast milk are contaminated with DDT, benzene, and dieldrin.
>
> Merchant 1996, p.194.

Short (1992) also noted the importance of women's "primary responsibility for health and wellbeing of the next generation", and the interdisciplinary teamwork approach that is required to address the problems, an approach that is "well served by women's ways of knowing" (p.507). Her observations were drawn, not from the literature, but from "the combined experiences I have had with many hundreds of women throughout Australia who are actively involved in fighting toxic risk" (p.507).

> "Why is it", Shiva asks, "that women sense destruction faster and are more persevering in the struggle against destruction? Why do they carry on when everyone else is cynical and hopeless? The reason is that women have a distinctive perception of what life is, a sense of what is really vital, which colours their view of what is at stake in the world."
>
> Breton 1998, p.218.

It is contended that there are other reasons too, including that women generally have less to lose socio-economically by challenging the status quo than men have, and women tend to be more vulnerable to chemicals than are men. Evidence of the latter will be provided in Chapters 3 and 4. Kate Short's and Vandana Shiva's comments draw attention to a subject that will be discussed further in Chapter 6, that of women's

[87] Low, Senior Lecture in the Faculty of Architecture, Building and Planning at the University of Melbourne; Gleeson, Research Fellow at the Urban Research Program, Australian National University. They cited as evidence Sontheimer 1991; Seagar 1993; Rocheleau, Thomas-Slayter & Wangari 1996.
[88] Dobson, Professor of Politics at Keele University.

knowledge and wisdom, and the contribution it can make to the pesticide policy process. For now, the task is simply one of noting the significant gender difference with respect to attitudes towards risks from pesticides, for it is contended that an ethical pesticide policy and the process by which it is arrived at must reflect these differences.

Gender appears to have an important effect on the perception of risk, not only by the lay person, but also by the expert. One survey found that female physical scientists judge risks from nuclear technology to be higher than do their male counterparts (Barke *et al.* 1997, p.167). A similar pattern occurred with female and male members of the British Toxicological Society, with respect to risk from chemical technology (Slovic *et al.* 1997, p.289,294). These two studies confirm the findings of an earlier one by Kraus *et al.* (1992) who had reported that, not only were female toxicologists more concerned by chemical risks than were male toxicologists, but also that the former "were less favorably impressed with the benefits of chemicals" than the latter (p.224).

Social status: race, education, income

No studies appear to have been carried out specifically to determine the impact of social status on risk perception, but several studies have yielded some limited information on the effects of race, income and education, providing at least some measure.

Flynn *et al.* (1994) found no difference in risk perception between non-white women and men. However they did find a significant different between white and non-white Americans, with a strong tendency to a higher risk perception by non-white than by white Americans (p.1105).

Govindasamy *et al.* (1998) found in one study that risk aversion to pesticides decreased with income, and in a second study that it increased. The result of the first study they reported to be more consistent with previous studies.[89] It is also consistent with the finding by Flynn *et al.* (1994, p.106) that the group of white males revealing lower risk perception had higher household incomes.

Studies regarding the effect of education on lay assessment of pesticides have produced conflicting results, although the weight of evidence appears to reside with a lower assessment of risk concomitant with a higher level of education. Govindasamy *et al.* (1998) found in their first study that those with higher levels of education were less concerned about pesticides, whilst the second study produced inconclusive results. They reported conflicting results from previous studies too, one showing increased

[89] Byrne *et al.* 1991; Dunlap & Beus 1992.

'aversion to pesticides' with higher education,[90] and one showing decreased 'aversion' with higher education.[91] Krewski *et al.*'s 1995 survey of the Canadian public found decreased 'aversion' to pesticide residues with increased education (p.122). Kraus *et al.* (1992) noted that "in general, respondents with a college degree had more favourable attitudes toward chemicals . . . and less concern about risks" (p.222-3).

Flynn *et al.* (1994, p.106) reported that, in their study, the group of white males revealing lower risk perception were better educated, had higher household incomes and were more politically conservative. The authors, concerned by the possible effects of income, education and other social and demographic variables on lay risk assessment, carried out a number of stepwise multiple regression analyses of their data. They concluded that the overwhelmingly important influence on lay risk assessment was 'the white male effect'. In their words, "white males stand out from everyone else in their perceptions and attitudes regarding risk" (p.1107), these being significantly lower than for other groups.

Flynn *et al.* posited an explanation for these findings:

> Perhaps white males see less risk in the world because they create, manage, control, and benefit from so much of it. Perhaps women and nonwhite men see the world as more dangerous because in many ways they are more vulnerable, because they benefit less from many of its technologies and institutions, and because they have less power and control.
>
> Flynn *et al.* 1994, p.1107.

They concluded that this material reveals "why traditional attempts to make people see the world as white males do, by showing them statistics and risk assessments, are unlikely to succeed" (p.1107).

These findings regarding gender and social status have important implications for pesticide policy. Kraus *et al.* (1992) noted that the toxicologists in their survey tended to be "highly educated, white males" (p.255). Slovic *et al.* (1995, p.664) reported that 76.7 percent of the toxicologists from the US Society of Toxicology who completed their survey were male. Again, in 1997, Slovic *et al.* noted that 66.7 percent of the toxicologists who completed a survey carried out amongst members of the British Toxicological Society were male (p.292). These figures, although not necessarily accurate representations of the actual percentages of male and female toxicologists, and failing to

[90] Dunlap & Beus 1992.
[91] Byrne *et al.* 1991.

provide racial information, nevertheless support the assertion by Jamieson (1996, p.42) that American scientists are "overwhelmingly white, male, and upper middle class" (Jamieson 1996, p.42). If this is the case, and if there is such a striking difference between the perception of risk by white males and by other members of society, and if pesticide policy decisions are made on the basis of their risk assessment, then there is an obvious equity problem. Flynn *et al.* 1994 (p.1104) noted that risk-acceptance advocates are predominantly white male, in contrast with the previously reported assertion by Barke *et al.* (1997, p.168) that risk-refusal advocates are predominantly female. The development of an equitable pesticide policy process would need to recognize and address the fact that risk assessment as carried out by white males is apparently not representative of that carried out by the other groups in society, regardless of their level of technical expertise, because at least of gender bias and possibly also racial bias. The attitudes and views about chemicals and risks that are common to the white male toxicologists differ from those of female toxicologists, and from female and non-white members of society.

Worldviews

Interwoven amongst gender and racial influences can be found other socio-political factors that influence risk assessment. A number of studies have demonstrated the important influence that social and political context can have on the risk assessments of both the technical experts and the public (Kraus *et al.* 1992, p.216; Slovic *et al.* 1995, p.663). Margolis (1996, p.21) broadly referred to some of these influences as differences in attitude towards the ends which public policy should serve, and about society's obligations to other humans and to nature—in other words about ethics, equality, and the distribution of power within society. Equality invokes concerns about children, as especially vulnerable, and about future generations, both groups relying on the fairness of the currently powerful people.[92] It is these attitudes and beliefs that constitute the shared value systems that underpin different ways of behaving, commonly referred to as worldviews (Dake 1992, p.28), and it is these worldviews that, together with the previously discussed factors of trust, gender, and social status, so powerfully influence the assessment of risk—both by the lay assessor and by the technical assessor. In reality gender, social status, and trust are all intricately interwoven within worldviews but, in order to emphasize the special role of these factors in the pesticide debate, they have

[92] Douglas (1985, p.6,10) found that a sense of justice or fairness comes into play in lay risk assessment: those who feel they are unfairly treated making an assessment of higher risk than those who do not so feel. She also drew a parallel between the distribution of actual risks and the distribution of power and status, in the USA at least and especially evident with respect to hazardous waste facilities.

been lifted out and examined separately. Now it is necessary to look at the broader category of worldviews.

In order to the better explain society's philosophical approaches to public policy, a number of cultural theorists (e.g. Douglas 1985, p.15; Thompson *et al*. 1990, p.63-4; Dake 1992, p.28) have used the approach of constraining all of humanity into a few categories of social relations that are characterized by particular worldviews. Other writers take issue with this approach: Ortwin Renn (1992), for example, criticized it as being "reductionist", "simplistic", and "unsubstantiated", although he acknowledged its merits, in particular its "emphasis on values and worldviews rather than interest and utilities" (p.75-6).[93] The objective here is not to determine whether or not the 'reductionists' views are 'unsubstantiated' or not, but rather to use their work to demonstrate the existence of different worldviews and the influence those worldviews might have on the assessment of risks, and hence decision-making about pesticides. In that vein, then, this section will identify the categories and note the survey results relating these to both technical and lay assessment of risk.

Various writers have tended to use slightly differing categorisation of the social relations underlying worldviews. The one used in the following analysis has been chosen solely because it has been used in a number of relevant attitudinal surveys. These categories are defined in Table 2.6 with respect to risk and to the environment.[94]

Table 2.6 Cultural patterns

Groups		Attitudes
Individualism		
	risk:	risk is opportunity; favour deregulation

[93] Renn, Associate Professor of Environment, Technology, and Society, Clark University, USA.
[94] Dake's (1992, p.28) categorisation differed only in that his fifth category was 'autonomous' instead of 'technological enthusiasm'. Douglas (1985, p.15) provided only four categories: utilitarianism (in which the aim is to provide the 'greatest good for the greatest number'); elitism (the well-being of society is based on the well-being of the best-off individuals); libertarianism (individual freedom should prevail except where it harms others); egalitarianism (the well-being of society is based on that of the worst-off person).

environment:	pro-nuclear; nature is benign and has abundance for all; greater interest in economic issues
Hierarchy	
risk:	risk decisions are best left to experts
environment:	pro-nuclear, nature is robust, but only up to a point, so promotes sustainable development
Egalitarianism	
risk:	mistrusts systems that pose hidden, involuntary and irreversible dangers; frame risk issues in ethical terms, especially equality
environment:	strongly anti-nuclear; nature is fragile; promotes precautionary approach
Fatalism	
risk:	has little control over risks, so why bother?
environment:	pro-nuclear; nature is capricious
Technological enthusiasm	
risk:	high technology society is important for improving health and well-being
environment:	presumably strongly pro-nuclear

Sources: Flynn *et al.* 1994, p.1101; Dake 1992, p.28.

A number of surveys have been carried out in recent years in an effort to ascertain the worldviews of the general public and toxicologists and to link these to the assessment of risk. In a survey of Canadian toxicologists and members of the public, Slovic *et al.* (1995, p.668-9) found that the public tended to have more egalitarian and fatalistic responses to questions than did the toxicologists. In 1997 Slovic *et al.* (p.300) found that only 40-45 percent of British toxicologists expressed egalitarian views. These results are supported by those of Krewski *et al.* (1995b, p.247) who found that 81.1 percent of the public expressed egalitarian views, although only 49.1 percent expressed fatalistic views. They found also a high correlation between the fatalistic and egalitarian views and high lay assessment of risk.

In 1992 Kraus *et al.* (p.220) found that toxicologists had a more favourable attitude towards chemicals than did the public i.e. were more technological enthusiasts. This finding was confirmed by Slovic *et al.* (1995, p.661). Krewski *et al.* (1995b, p.247) found that only 43 percent of the public agreed that chemicals have improved health more than they have harmed it, i.e. could be considered technological enthusiasts with respect to

chemicals, whereas Slovic *et al.* (1997, p.300) found 71.3 percent of technological enthusiasm with respect to chemicals amongst British toxicologists.

Slovic *et al.* (1997, p.300) found that 57.1 percent of British toxicologists agreed with the hierarchism position that decisions about health risks should be left to experts, whereas Krewski *et al.* (1995b, p.241) found that only 38.8 percent of the Canadian public agreed with it.

Finally, it is worth noting the effects of gender on worldview: Slovic *et al*. (1995, p.668-9) found that, amongst toxicologists, males were more inclined to the view that decisions about health risks should be left to experts (hierarchists), that people with more ability should earn more money (individualists), and attached more importance to high technology for improving health and social well-being (technological enthusiasts) than females. Flynn *et al.* (1994), in reporting on the gender effects on worldviews of members of the public, noted that the group with the lowest risk perception—white males—were politically conservative and could "be characterised by trust in institutions and authorities and a disinclination toward giving decision-making power to citizens in areas of risk management" (p.1106), i.e. were hierarchists. Kraus *et al.* (1992, p.216,224) found that toxicologists working for industry took a more benign view of chemicals than did those working in academia or for the government, i.e. had greater 'technological enthusiasm'. This is consistent with the gender differences in risk perception, for Slovic *et al.* (1997, p.302) found that female toxicologists were more likely to work in academia than in industry.

In summary, then, a comparison of the worldviews of the public and of toxicologists might look like this:

- public: egalitarians and fatalists:
  higher assessment of risk.

- toxicologists: technological enthusiasts and hierarchists:
  lower assessment of risk.

- males: individualists, hierarchists and technological enthusiasts:
  lower assessment of risk, higher assessment of benefit.

- females: egalitarians:
  higher assessment of risk, lower assessment of benefit.

The most striking feature of these findings is the strong contrast in the worldviews of the public and the toxicologists: on the one hand the egalitarians, and on the other the technological enthusiasts. This contrast is again underscored by differences between males and females, the views of males tending more towards those of the toxicologists. Although the majority of surveyed toxicologists have been males, the gender effect is not sufficient to explain the difference between public and toxicologists, for that difference persisted even where the toxicologists were female, although at a diminished level.

This striking difference in worldview between the public and the toxicologists provides fertile ground for equally striking differences in assessment of risks. For where facts are uncertain, and judgements must be made, as is the case with both lay and technical risk assessment, worldviews become vitally important. The uncertainty and lack of factual evidence that characterizes technical assessment of risks from pesticides will be scrutinized in Chapter 3, and the ways in which the value systems of toxicologists might influence their judgements will be elucidated. All judgements issue from the value system of the person who makes them, and the value system determines the worldview. Gender, race, education and income also form part of this worldview, and they have been shown to bear a strong influence on assessment by the lay and the technical assessor (at least, gender has for the latter). Worldview influences how a person votes in elections and Kraus *et al.* (1992), building on this, noted that one study on expert assessors found that attitudes to risk assessment were "strongly related to whether they . . . had voted Democratic or Republican in the previous presidential election" (p.216).[95] They commented that a number of investigators have argued that "the ambiguities and uncertainties of risk assessment are fertile grounds for influence from political and ideological considerations" (p.216).

Paul Slovic provided a similar view in 1987 when he stated that "experts judgements appear to be as prone to many of the same biases as those of the general public, particularly where experts are forced to go beyond the limits of available data and rely on intuition" (p.281). In 1997 he was more specific in this charge:

> Disagreements among toxicologists are systemically linked to gender, affiliation (academic versus other), worldviews, and affect. Thus, affective and sociopolitical factors appear to influence scientists' risk evaluation in much the same way as they influence the public perceptions.
>
> Slovic 1997, p.87.

[95] Kraus *et al*. (1992) cited Lynn 1987.

Indeed, Drake (1992) offered the proposition that "risk is employed as a rhetorical resource to defend particular worldviews" (p.24).

2.2.3 Technical expertise in lay assessment

Whilst the emphasis in this chapter has been placed on social rationality, and especially on the effects of trust, gender, and worldview on lay assessment of pesticides, it is important to point out that lay assessment may also include some degree of knowledge of the technical aspects of pesticides. That level of knowledge may be quite extensive for public interest groups and many individuals who have undertaken some study of pesticides, particularly their effect on health and the environment.[96] It would, therefore, be incorrect to leave the impression that all lay assessment is made solely on the basis of social determinants, a form of social reductionism that particularly concerned Shrader-Frechette (1985, p.15). According to Sylvia Tesh (1999), the traditional but fallacious view of the dichotomy between lay risk perception and expert assessment as reflecting the difference between social values and scientific expertise, derives directly from the work of Paul Slovic who, since the late 1979s, has provided the empirical foundations for the subsequent analysis of public risk perception.[97] The dichotomy overlooks the fact that citizens express their perception of risk largely through organized citizen groups, which in turn employ and have access to many technical experts, according to Tesh (1999, p.39). Thus, Tesh asserted, the differences in assessment between public and regulators becomes not one of social values versus science, but rather one of conflicting science. Tesh illustrated this argument with the Alar case, in which the US's Natural Resources Defense Council (NRDC) utililized only data from US government scientists, using technical experts to analyze it, and seeking endorsement of that analysis from other experts outside of the NRDC:

> NRDC was doing science. The organization didn't conclude that Alar was hazardous because Alar is 'unknown', and 'dread'. It didn't' publish an ethical treatise calling Alar risky because exposure is involuntary, hidden, and uncontrollable. It didn't bring up values like fairness and equity. Instead, NRDC used the same kind of reductionist scientific rationality that Slovic and his colleagues labelled 'expert'.
>
> Tesh 1999, p.49.[98]

[96] This may be especially so for individuals who have been affected by a particular pesticide through spray drift, such as 2,4-D.
[97] Tesh, School of Public Health, University of Michigan.
[98] Alar is a pesticide that was used on apples and had a tendency to leave residues that turned up in apple juice and apple sauce as well as the raw fruit, all foods common in children's diets (Tesh 1999, p.46).

The publication of the NRDC's (1989) analysis, showing a high risk of cancer and neurological disorders amongst pre-school children because of a high level of ingested pesticide residues, caused a "whirlwind of media stories, consumer fear and industry fury" (Tesh 1999, p.46). Alar, the main offender, was withdrawn from the market. Over the years since, there have been numerous writings asserting that a good chemical was withdrawn because of unfounded public fears about chemicals, public hysteria based on misguided perceptions of risk (e.g. Wildavsky 1995). There was an intense attack by scientists (Tesh 1999, p.460). Yet, as Tesh pointed out, "the case cannot accurately be characterized as a split between experts and citizens" (p.47). Those who undertook it were "like the 'experts' Slovic and his colleagues interviewed, people with 'professional involvement in risk assessment'" (p.47). The difference in opinion was thus a difference in expert opinion about scientific 'facts', that difference arising out of choices about which sets of data on food intake and which toxicological studies to use, according to Tesh (1999, p.47). Four years after the NRDC study was published, the premier US scientific authority, the National Research Council, published a study (NRC 1993) that essentially corroborated NRDC's major conclusion (Tesh 1999, p.48).

The point that Tesh (1999) illustrated with this example is that lay assessment should not be regarded as being only that of social values. For she contended that citizens with a concern about, in this case pesticides, tend to organise themselves into groups, or be drawn to existing groups, to help change the pesticide policy agenda. In so doing, they also draw in and utilise technical expertise to present their case. That of course does not mean that such groups and people limit themselves only to scientific reasoning, but rather that they bring both social values and scientific reasoning to bear on the issue, as indeed it will be shown later, do scientists. Thus the risk perception literature "oversimplifies the concept of experts by assuming that experts deal only in facts" and "it oversimplifies the concept of citizen by assuming that that citizens deal only in values" (Tesh 1999, p.42). This problem arises because risk perception analysts overlook the role and influence of organised public interest groups through which citizens influence the policy agenda and derive their information about pesticides. One of the messages derived from the NRDC case, according to Tesh (1999, p.50), is that not only does the public think pesticides are dangerous but also that scientists think this too.

Conclusion

There appears to be a sharp divide between experts in the field of risk assessment as to the rationality or irrationality of the assessment of risk by the public. Generally such assessment is referred to as 'perception', a term which serves to subtly undermine its claim to rationality. Many technologists, and advocates of science as the basis for 'sound' decision-making, believe lay assessment to be irrational (e.g. Margolis 1996), whilst those who have studied it closely tend to see its relevance and to grant it validity equal to that of the technocrats (e.g. Slovic 1992, p.150).

Underlying the failure of technical risk estimates to accurately reflect risk assessment of pesticides by the public may lie a whole variety of sociological, cultural and psychological factors. It is contended that lay assessment is not necessarily based entirely on an assessment of risk to the individual's health through direct exposure, spray drift, food and water residues, or even to the environment through contamination, but may bring into play the individual's deeper value systems. These may include the desire for caution in the face of uncertainty, and the desire for choice in ingesting pesticide residues. An "intensely personal invasion" is how MacIntyre *et al.* (1989, p.13) referred to the existence of residues in food consumed by health conscious consumers. There are unanswered questions about the effect of pesticides on the overall functioning of the ecosystem. There may also be an intuitive unease with the concept of continuous application of small amounts of chemicals to the food chain, to human beings, and to the environment, and a belief that the human species does not have a moral mandate to so tamper with a system that is not theirs to tamper with. The assessment may include deep ecology or spiritual approaches in which the inherent worth of the environment is given status or, as Carolyn Merchant (1996, p.xxii) put it, Earth is regarded as "home to a multitude of other living and nonliving things, many of which are beautiful and inspiring in their own right"— a subject that will be explored in Chapter 5. There may be a view that the use of pesticides is part of, and supports, a larger industrial system that is based on greed and that oppresses people in lower-socio economic groups and 'developing' countries. There may also be a deep distaste for many attributes of modern society that speak of self-interest above the interest of the community, of the attitude of domination, of the place which modern political power has awarded the economy, and the free-market ideology that fosters corporate control of agricultural production systems and disempowerment of the small farmer. These are all issues that may influence the assessment particularly of those with an egalitarian approach to distributive justice. Wolfgang Van den Daele provided a neat summary:

> Resistance to technology is fuelled by fundamental reservations about value systems that in our society culturally favour technological modernization, moral utilitarianism, political pragmatism, instrumental activism, and the individualism that governs economic life. The conflicts about technology address the classical themes of political struggle: social inequality, the objectives of desirable social development, the distribution of power, and the scope of democratic participation.
>
> van den Daele 1993, p.158.[99]

Many such underlying factors may be more or less subconscious and hence not verbally expressed by the public, and especially not captured by attitudinal surveys. However, they will influence lay assessment of risk. The failure to recognize the "social foundations of risk framing" (Wynne 1992, p.278), and the consequent failure to address the real debate behind the risk arguments means that not only is the debate never resolved, but opposing views become further entrenched. The real debate, according to Conrad Brunk, Lawrence Haworth and Brenda Lee (1998, p.1,6), is one primarily about values. Risk debates are not debates between "good and bad science" (p.1), they are political debates, about value frameworks and moral values, about "different conceptions of society, different attitudes toward technology and toward risk-taking itself" (p.7). A similar view was espoused by John Graham and Lorenz Rhomberg (1996, p.22), that risk conflicts are primarily about conflicting interests between individuals and groups within society.[100] The polarisation of views over risks from pesticides appears, then, to reflect a more general social and political polarisation, rather than ignorance and irrationality. It reflects a debate about "the kind of society in which we want to live" (Douglas 1985, p.18). Choices about the risks associated with pesticides, become a matter of values and beliefs about social institutions and moral behaviour (Gough 1990, p.25).

As Harry Otway (1992, p.219) pointed out, whoever it is that has the power to define the limits of the risk discourse, also implicitly decides who is behaving rationally.[101] In other words, what is often regarded as irrational is, in fact, perfectly rational when viewed against the background of values and ethics from whence it arose. An acknowledgement has emerged, at least by some writers, that there is not one rationality,

[99] Dr Van den Daele, Professor of Sociology, Free University of Berlin.
[100] Graham, Professor of Policy and Decision Sciences and Rhomberg, an assistant professor, Harvard School of Public Health.
[101] Otway, Science adviser on the executive staff of the Director of the Los Alamos National Laboratory, and co-chair of a joint community/laboratory working group to address community health concerns.

that science does not have a monopoly on rational thought—there are in fact different rationalities depending on one's reference system, and these can be loosely grouped as social rationality, as differentiated from scientific rationality. Kristin Shrader-Frechette concluded that:

> . . . determining when a risk evaluation is rational is as much a prerogative of the people as of the experts.
>
> Shrader-Frechette 1991, p.13.

The notion that there is but one form of rationality within science is also challenged by Shrader-Frechette (1991) and will be further investigated in Chapter 4.

But nothing changes

The recognition that the public's assessment of the risks from pesticides is the rational outcome of a whole set of complex social issues is not, in itself, enough. Even where writers appear to recognize the public rationality, if they themselves unquestioningly support the technology in question they may act in a manner that directly undermines the public's position. Such is the case with Peterson and Higley (1993), who appeared to recognize "the legitimate basis for many public attitudes on risk", and stated that "there is rationality behind the public's seemingly irrational concerns about pesticides" (p.207). They recognized that communication means listening to as well as informing. They stated that scientists should "empathize with and genuinely consider public concerns" (p.208). Yet they still exhorted their fellow scientists to dissuade the public from their "perceptions" by telling them about "actual" risk, least there be a "crisis", the inference here being that there would be a crisis if the public rejected pesticide technology (p.206). They stated that "in most cases human-health risks associated with pesticide use are actually very low [although] the public consistently ranks pesticide use as being very risky" (p.206). The point is that no matter how much theoretical recognition there is of the public's right to its views, in practice that recognition recedes behind the earnest pursuit of the technology, and becomes merely lip service. Even though Peterson and Higley (1993, p.211) acknowledged Slovic's (1987) view that the public assessment is much richer than that of the expert, involving legitimate concerns omitted by the expert, they still persisted in a belief that the public view is a problem of "scientific literacy" (p.210).

This lingering perception that technical risk assessment provides *accurate* information on *actual* risk requires, therefore, that the process be critically examined, particularly in light

of the influence of value systems on assessment.[102] This task is undertaken in the next chapter.

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[102] The New Zealand government's discussion document on radio frequency transmitters (MfE & MoH 1999) touched on the issue of public assessment versus technical assessment. It included case law that supported the view that fear arising from lay assessment is an adverse effect to be taken into account "when the fear is well-founded, based on what a reasonably well-informed member of the community might think, and if there is some opportunity to prevent apparent danger". In *Shirley Primary School v Telecom Mobile Communications Limited* the Environment Court agreed that fear is an effect to be taken into account, but qualified its view by relating it back to technical risk assessment (at page 125):

> *. . . but whether it is an effect which should be given any weight depends on the assessment of risk.*

The Court said further (at page 126):

> *. . . we have found that such fears can only be given weight if they are reasonably based on real risk.*

In other words fear arising from lay assessment of risk will only be recognised by the Courts if it is supported by technical risk assessment.

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Chapter 3 Technical Assessment of Pesticides

> The globalisation of trade in chemicals and products makes it possible for products to spread over the world much quicker than before. The possibility to discover health or environmental effects at an early stage is limited. Instead, there is a clear risk that large scale spread of the chemical has already occurred before adverse effects appear.
>
> Chemicals Policy Committee 1997, p.14.

Introduction

The currently favoured frameworks for policy development are based primarily on economic rationale, with a greater or lesser degree of moral/social guidance depending on the current philosophical state guiding the particular nation. However, scientific rationale has increasingly become a predominating feature in the development of policy, with technical risk assessment being touted as the scientific method of sound decision-making. In New Zealand, risk assessment has been elevated to an almost inviolable status with its inclusion in laws like the HSNO Act 1996. Such a move follows the path carved out by the USA's regulatory risk assessment processes. The combining of the economic and the scientific rationale reaches its zenith in risk management where the 'scientifically' derived risks are balanced against the potential financial benefits, a process which involves the concept of benefit for one group of people (assumed, but often falsely so, to be the majority), at the expense of another.

Both economic and scientific analyses are generally claimed by their proponents as logical, rational explanations of 'as near to the truth as we can currently get'. Indeed, this instrumental rationality has come to be regarded by some as the *only* form of rationality, all other bases for decision-making involving subjectivity and therefore being 'irrational'. There are two problems with this approach. The previous chapter has already demonstrated that lay assessment of risk includes non-instrumental valuation processes that give rise to rational assessment consonant with those values. The second problem lies with the assumption of objectivity in both the economic and scientific analyses, both of which are, however, based on assumptions and value judgements frequently not made explicit. In economic analyses the utility and welfare functions are based on the premise of individual rational choice, which ignores many of the socio-political/cultural factors that have been demonstrated to affect choice, and indeed also underlie economists' own determination of what is rationality. Similarly, technical risk assessment, which is generally portrayed as being value-free, objective, and socially-neutral, is in reality subjective, values-determined and oriented to particular social outcomes as will be demonstrated in this chapter and in Chapter 5.

This demonstration of the subjectivity involved in technical risk assessment is not new. Shrader-Frechette reviewed the problem in a more general sense in 1985, and in 1991 (p.31) noted that a number of 'cultural relativists', such as Douglas and Wildavsky (e.g. 1982), had also written on the subject. Since then numerous other writers have visited the subject, as was mentioned in the preceding chapter, section 2.2.2.[1] Yet, despite these careful analyses and well-known expositions, the use of science in public policy is still promoted as being objective and value-free, and the use of risk assessment as being the only rational method of decision-making (Armour 1997, p.44). Therefore, at the risk of covering old ground, it was deemed necessary to analyse, specifically, the regulatory risk assessment of pesticides and the toxicological basis of that assessment. Slovic (1997) commented that toxicology's "quantitative estimate of a chemical's carcinogenic risk [is] based on theoretical models, whose structure is subjective and assumption-laden, and whose inputs are dependent on judgement" (p.63). This chapter is devoted to teasing out these issues of assumptions and subjectivity in that part of the risk assessment process that is based on toxicology, thus elucidating the nature of scientific rationality. It will first describe the toxicological assessment process and then reveal the problems inherent in each part of it, concluding with an analysis of the value systems that underlie the subjective judgements. These value systems will be picked up again in Chapter 5, following an analysis of some of the failures of technical risk assessment in Chapter 4, and will be contrasted with those that underlie an ecocentric approach to assessment.

3.1 Risk

The term risk has been used on numerous occasions already in this thesis, but it has not been defined. Now it will be. It is a little unusual to refrain from defining a term until some considerable time after its first use, but there is a good reason for this. When members of the public make an assessment about pesticides, they do not do so on the basis of a definition of risk, but rather on the basis of a number of social and cultural factors which largely fall outside the parameters of the usual, technical, definition. It is contended that it is important to first gain an understanding of factors that influence members of the public to make the assessments and choices that they do make, before narrowing the debate to an instrumental definition of what constitutes technical risk.

Risk has been defined in any manner of ways, varying significantly with the context in which it is used. One relevant definition was reported by Luhmann:

[1] Reference was made to Shrader-Frechette 1985, 1991; Gough 1990; Mayo & Hollander 1991; Krimsky & Golding 1992b; Cothern 1996; Kunreuther & Slovic 1996; Keeney 1996; Slovic 1997; Brunk *et al*. 1998.

> A hazard, in our parlance, is a threat to people and to what they value (property, environment, future generations, etc.) and risk is a measure of hazard.
>
> Kates & Kasperson 1983, p.7029, cited by Luhmann 1993, p.7.

That definition could cover the social and cultural factors described in the preceding chapter, depending on what the 'etc.' includes. However, it is not usually so construed with respect to pesticides. Additionally, it does not indicate any measure of benefit. The term risk, nevertheless, is commonly used in a manner that implies there are certain advantages to be gained, but only if something is at stake, "a matter of a decision that, as can be foreseen, will be subsequently regretted if a loss that one had hoped to avert occurs" (Luhmann 1993, p.11).

Douglas (1985, p.20) provided two differing views of what is meant by risk with regard to chemical toxicity, both originating with the United Nations:

i. Risk can be estimated as the expected frequency of adverse effects arising from exposure to a chemical.

ii. Risk can be estimated as the probability of an exposure times the severity of the adverse effect (harm) or hazard.

Although at first glance these appear essentially the same, there is a difference in emphasis: the first of these definitions places the focus on the probability of occurrence, but the second places equal emphasis on the severity of the adverse effect and on the frequency of the effect occurring. Such an apparently fine distinction is of major significance, for it reveals something of the value systems that underlie conflicting views of risks such as may be espoused by regulators and policy makers on the one hand, and by the public on the other, with the consequent rejection of the one's view by the other. It was Luhmann's view that decisions on risk become a matter of the degree of loss and the degrees of sensitivity to probabilities (Luhmann 1993, p.101): whereas the regulator might be more sensitive to the degrees of sensitivity to probabilities, the public might be more sensitive to the degree of loss associated with the risk.

The first of the United Nations' definitions reflects the current risk management paradigm of decision-making based on probabilities of events occurring. Yet, Kates and Kasperson's definition suggests that, in determining public policy, perhaps greater emphasis might need to be placed on the hazard, or degree of loss. Their definition provides a hint of the importance of values, which are not well captured by probabilities. This notion of re-focussing the policy emphasis from probability to hazard is given

further treatment in Chapter 5, section 5.5.3 and Appendix 2, with a proposal for a hazard-based rating system for implementing the principle of minimum harm, in contrast to the more fashionable risk-based indicator systems currently proliferating across the academic and regulatory spheres of endeavour. Support for this approach could also be derived from the following comments by Douglas regarding the ecological effects of hazards, and by Bernd Rohrmann regarding the human health effects of hazards.[2] Douglas, in describing the engineering, ecological and cognitive science approaches to risk perception analysis, pointed out that the ecological approach:

> . . . is careful to distinguish the term hazard from risk. Indeed, the shift of terminology helps to bridge the difference between plant ecology and human ecology, for the living elements in the former can be said to react to hazards whereas they do not act (by definition) as rational agents calculating risks.
>
> Douglas 1985, p.24.

In other words, what is of relevance in ecology is the hazard, and what is assumed to be of relevance to humans is the cognitive approach of rational reaction to the probability of that hazard. Technical risk assessment does not recognize the cognitive element of risk emphasised by social theorists, instead concerning itself only with the probability of the ecologically hazardous effect occurring. Rohrmann subsequently noted that this same technical approach holds problems for human health:

> . . . formal risk definitions which are common in risk analyses within engineering or insurance (such as the product of probability and severity of damage) are hardly appropriate for risk to human health and well-being.
>
> Rohrmann 1993, p.270-1.

Rohrmann did not, unfortunately, provide a definition that he would regard as being appropriate to human health, but did provide a clue when quoting the World Health Organisation:

> The principle criterion of all protective measures, human health, is defined diversely: in a narrow sense as the absence of disease, and in a wider sense as a 'state of complete physical, mental and social well-being', as expressed in the founding articles of the World Health Organisation (WHO 1946).
>
> Rohrmann 1993, p.273.[3]

[2] Rohrmann, Professor, PPE Faculty, University of Mannheim.
[3] Reference details for WHO 1946 omitted in Rohrmann 1993.

What this tends to indicate is that a risk assessment process for pesticides should take cognisance of mental and social well-being as well as the technical end-point indicators of physical health. In fact, Rohrmann expanded this concept to include "somatic, psychological, social and economic" effects, which harks back to Chapter 2 and the involvement of social issues in lay assessment of risk.

Renn added a third dimension to the definition of risk, that of reality:

> . . . the definition of risk contains three elements: undesirable outcomes, possibility of occurrence, and state of reality.
>
> Renn 1992, p.58.

By the state of reality Renn meant the "degree to which human knowledge reflects reality" (p.58). This concept, although rarely expressed as such is, on closer analysis, very self-evident and is widely supported at least in the social sciences, which have a tendency to regard risk as a concept invented by humans to cope with uncertainties and dangers. Slovic (1992) expressed it very succinctly: "there is no such thing as 'real risk' or 'objective risk'" (p.119). Yet toxicology is widely portrayed as providing objective measures of real risk. Toxicology pays only scant attention to Renn's third element, and this by providing default factors of ten to cover for the uncertainty deriving from the degree to which human knowledge is lacking. It is contended that where the uncertainty factors fail to reflect the state of reality, it is the latter which is rejected rather than the former, a problem that will become apparent in Chapter 4 with the analysis of multiple chemical sensitivity.

The US Presidential/Congressional Commission on Risk Assessment and Risk Management (P/CCRARM) also added a third condition to risk:

> Risk is defined as the probability that a substance or situation will produce harm under specified conditions.
>
> P/CCRARM 1997, p.2.

This third condition is vitally important in that it limits the validity of a risk assessment of pesticides to exposure situations that are identical to the 'specified conditions'. Usually the specified conditions involve use of protective clothing, assumed to function properly. Perfectly functioning application equipment is also assumed. Both these conditions are frequently not met in practice, and the effect of different assumptions relating to exposure on the final outcome of a risk assessment may be profound, as will be demonstrated later in this chapter, in section 3.5.3.

Another version of risk, specifically arising from the failure of toxicology to reflect the human experience of multiple chemical sensitivity, has been advanced recently by Dr Claudia Miller (1997).[4] It also contains three elements, the third one this time being the interaction of the substance with the human being. That interaction depends upon a number of variables including genetic predisposition, nutritional and diseases status, previous exposure to chemicals, and psychological stress. In other words risk = hazard x exposure x recipient. Unfortunately, although Renn's third element is superficially addressed by toxicological risk assessment and then ignored, Miller's third element is not addressed at all. It could be argued that ERMA's (1999) definition of risk, as "the combination of the magnitude of an *adverse effect* and the probability of its occurrence" (p.5) [emphasis added], does leave room for the incorporation of Miller's third element, but subsequent reference to standard health risk assessment procedures based on hazard identification leaves it clear that that is not ERMA's intention (ERMA 1999, p.18).

3.2 Risk assessment

Risk assessment of some type is carried out by everybody, virtually every day of his or her life. Any choice between two possibilities involves some assessment of risks. One major difference between this type of risk assessment and that which is frequently referred to as scientific (or probabilistic) risk assessment is that, in the former, risks are generally assessed intuitively or at least qualitatively as an exercising of judgement, whereas the latter relies on quantitative assessment of scientifically derived data—although this also involves a considerable exercising of judgement. Another major difference is that, in the first instance, the assessment usually involves consideration of a range of real options, but in scientific/technical assessment there is no consideration of alternatives to the product/process that is being assessed.

Renn (1992, p.55-8) provided a useful categorisation of various types of risk assessment, based on a common differentiation of risk as a technical attribute or as a social construct:

Technical Attribute:

i. Actuarial approach—uses statistical data and extrapolated predictions.
ii. Toxicological and epidemiological approaches—use models, experiments, and surveys.
iii. Engineering approach—uses probabilistic risk analysis, e.g. fault trees.

Social Construct:

[4] Miller, Clinical Assistant Professor in Allergy and Immunology, University of Texas, San Antonio.

i. Economic approach—uses risk-benefit comparisons. Risk is expressed as expected individual utility losses, discounted for future consequences, with the goal of maximising utility for society as a whole.
ii. Psychological approach—uses psychometric analysis, personal preferences.[5]
iii. Sociological theories—uses analysis of equity, justice and fairness, judgement of risk linked to social values.
iv. Cultural theory—derived from anthropology, culturally shared values, cultural patterns structure the mind-set. Uses grid-group analysis.

Whereas technical science portrays risk as "some objective function of probability (uncertainty) and adverse consequences" (Slovic 1997, p.62), social science tends to regard risk as a construct, a concept developed by human beings to help them cope with uncertainty, and so is inherently subjective (e.g. Rück 1993). Some writers have tended to place economic risk assessment in a separate category lying between technical and social approaches, but Sheldon Krimsky and Dominic Golding (1992a, p.356) saw it as more closely aligned with that of technical science.[6] This is because risk measurement in economics, as in science, is based on 'rationality' and the maximisation of utility, although there is likely to be some acknowledgement of factors that cause public behaviour to diverge from the normative model. It is their view that "the economic theory of risk is supported by those who seek a pure, rational approach to policy making and who believe that there is a single form of rationality" (Krimsky & Golding 1992a, p.357). Brunk *et al.* (1998) came to a similar conclusion in their intensive scrutiny of the regulatory decisions surrounding the banning of the herbicide alachlor in Canada.[7]

This thesis will not explore all of the types of risk analysis as such. That task has already been performed in books such as *Social Theories of Risk* (Krimsky & Golding 1992b), *Risk is a Construct* (Rück 1993), *Risk Analysis and Scientific Method* (Shrader-Frechette 1985), *Risk Assessment of Chemicals* (van Leeuwen & Hermens 1995). The intention, instead, is to confirm the necessity of a different approach to rationality in pesticide policy, an approach that incorporates social rationality with ecological rationality, the latter being the subject of Chapter 5. Specific attention is therefore paid to technical risk analysis in

[5] Psychometric analysis seeks to elicit information on expressed preferences and perceptions of individuals.
[6] Krimsky, Professor of Government and Geography at Clark University; Golding, Center for Risk Management at Resources for the Future, USA.
[7] The case referred to is that of the cancellation of the registration of alachlor by the Canadian Minister of Agriculture in 1985 on the advice of the Health Protection Branch of Health and Welfare Canada, the ensuing appeal by Monsanto Canada Inc, and the subsequent recommendation by the Alachlor Review Board in 1987 that the registration be reinstated. The Minister did not implement the recommendation and, until 1991 at least, the herbicide remained unregistered. The case is notable for the clear evidence of the role of values in the risk assessments arrived at by the various organizations involved.

the form of the toxicological assessment of pesticides, and to social science interpretations of risk as a means of understanding, and legitimating, the differences between lay and technical risk assessment. Economic risk assessment is briefly addressed in this thesis, to the extent that the assessment of benefits and costs of pesticides, both individual and in total, is an important ingredient of pesticide policy in the USA (Barnard 1996), New Zealand (ERMA 1998) and other countries. Economic risk assessment as such lies beyond the scope of this thesis. It is, however, recognised as an important ingredient in policy development, and an economic risk assessment model that would provide an appropriate contribution would be one that breaks with the traditional tendency of economic theory. The tendency referred to is that of basing economic analysis on assumptions of narrowly defined rationality and linearity which, in its struggle for elegance and simplicity, unfortunately does not sufficiently accommodate the richness and complexity of human interactions with each other and their environment. There are, of course, exceptions and Krimsky and Golding (1992b, p.357) paid tribute to Kunreuther's (1992) incorporation of empirical observations in an effort to provide prescriptive guidelines for low probability-high consequence events, which conforms more closely to social behaviour than does the normative model of expected utility theory. An appropriate economic risk model, informed by the content of this thesis may be of use for pesticide policy implementation, but would be the subject of a thesis in itself.

3.3 A potted history of toxicology

The following very brief review of the history of toxicology is included to provide context for that discipline's role in the modern regulatory risk assessment of pesticides.

Most historical reviews of the science of toxicology find its origins in the mists of antiquity, in ancient Babylonian, Roman and Greek times (e.g. Gallo & Doull 1991; Lu 1996; Ballantyne, Marrs & Turner 1993; Rodricks 1992). One of the earliest texts on the subject appears to be the Ebers Papyrus, circa 1500 B.C., which described the plant poisons hemlock, aconite and opium, and metals such as lead, antimony and copper (Gallo & Doull 1991, p.3,4; Timbrell 1995, p.2). Much is made of the antiquarian propensity for poisoning as a means of state execution (by Socrates: 470-399 B.C.), a method of suicide (by Demosthenes: 385-322 B.C.), for murdering husbands (Catherine de Medici), or murdering children (Gallo & Doull 1991, p.3-5).[8] Indeed, Michael Gallo

[8] Catherine Deshayes was convicted of poisoning over 2000 infants in France during the Middle Ages.

and John Doull (1991) referred to toxicology as "a borrowing science that evolved from the ancient poisoners" (p.3).[9]

Much is also made of the role of Philippus Aureolus Theophrastus Bombastus von Hohenheim-Paracelsus (1493-1541) in toxicology. More commonly known as Paracelsus, he is variously referred to as the forefather of toxicology (Lu 1996, p.5), a charlatan and a fraud (Goldstein 1990, p.141), an alchemist who mixed "scientifically advanced notions and fanciful superstitions" (Rodricks 1992, p.39), and a revolutionary thinker (Gallo & Doull 1991, p.5).[10] It was Paracelsus who gave the world the concept of 'the dose makes the poison':

> What is there that is not poison, all things are poison and nothing (is) without poison. Solely the dose determines that a thing is not a poison.
> Paracelsus, cited in Deichmann, Henschler, Holmstedt & Keil 1986, p.210.[11]

This concept is the basis of modern toxicology,[12] and the ensuing risk assessments of pesticides depend entirely upon it although, as Norman Aldridge (1996) pointed out, Paracelsus was in fact referring to the therapeutic use of substances for patients, not poisons to kill things.[13] Most toxicology texts pay homage to Paracelsus and the dose concept.[14] One text, by Alice Ottoboni (1984), is even titled *The Dose Makes the Poison*.[15] Many social science authors also refer to the concept when writing about chemical risks and public 'perception' (e.g. Margolis 1996; Thompson *et al.* 1990; Wildavsky 1988, 1995; Breyer 1993, p.9). The concept remains largely, but not entirely, unquestioned.

Toxicology continued to develop principally in the field of pharmacology throughout the ensuing centuries. Much of this development involved the careful description of the adverse effects of drugs, and even some experimentation on humans (Ballantyne *et al.* 1993, p.3). Catherine de Medici carried out extensive experimentation in toxicology on

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[9] Gallo, Robert Wood Johnson Medical School, New Jersey, USA; Doull, Professor of Pharmacology and Toxicology, University of Kansas, Kansas, USA.

[10] Loomis & Hayes (1996, p.3), however, referred to Orfila (1787-1853) as the father of modern toxicology because he was concerned with harmful as well as therapeutic chemicals, whereas only the latter was the focus of Paracelsus's work.

[11] Translated from the first edition of Paracelsus's *Third Defense* contained in *Septem Defensiones*, 1564, by the authors.

[12] Modern toxicology is defined by Gallo & Doull (1991) as "the study of the adverse effects of xenobiotics" (p.3).

[13] Aldridge, Professor of Biochemical Toxicology, University of Surrey Robins Institute of Health and Safety, Guildford, UK.

[14] For example Gallo & Doull 1991; Lu 1996; Rodricks 1992; Ballantyne *et al.* 1993; Timbrell 1991; Aldridge 1996.

[15] Ottoboni, Toxicologist, California Department of Health Services, USA.

humans, her motive being foul play. She tested toxic concoctions, noting onset of action, potency, site of action and specificity, and clinical signs and symptoms.

Foremost in the field of human experimentation, and from a more humanitarian perspective, was Dr Samuel Hahnemann, the founder of the medical discipline of homoeopathy (Ballantyne *et al.* 1993, p.3). Based on Francis Bacon's principles of the "Inductive Science of Medicine", Hahnemann's work was characterised by "his constant appeal to experience, to facts of observation" (Close 1989, p.26-7), which distinguishes it from the practice of modern toxicological risk assessment in which the observation of human experience tends to be discounted if it is found to be at variance with the results of the laboratory experiments and mathematical deductions of toxicology.[16] Hahnemann tested on himself, his friends, and his patients thousands of substances known to have poisonous effects in his efforts to describe their curative properties. Homoeopathy can, in a sense, be seen as an extension of Paracelsus' concept 'the right dose differentiates a poison from a remedy', although homoeopathic cures depend on the atomic resonance of a substance, rather than material quantities of it, interacting with the vital force of the person (Vithoulkas 1980, p.91-3).[17] Interestingly, Paracelsus also referred to this vital force and its effect in curing people, according to homoeopathic practitioner and teacher George Vithoulkas (1980, p.59). Hahnemann proposed the law of curing of *similia similibus curentur*, or 'let likes be cured by likes', in which an appropriate dose of a substance will cure the symptoms identical to those displayed by a person subjected to poisonous doses of the same substance (Koehler 1986, p.20). Hahnemann's philosophy of curing, based on 'the dose makes the cure', was originally printed in 1796 then given its final form in his classic work *Organon of the Rational System of Medicine*, published in 1810 (Koehler 1986, p.20).[18] Toxicologists are dismissive of apparently positive results of homoeopathic medicines as being purely a placebo effect, on the basis that material amounts of a substance are required for an effect to occur. In other words, the doses of substance found to be curative by Hahnemann are too low to achieve any effect at all, according to modern toxicology. This brief discourse on homoeopathy may at first glance appear to be an unnecessary diversion. It is, however, provided here as an illustration of an early challenge to the concept of a positive dose-response and the concomitant assumption of no effect at low doses of substances—

[16] This is particularly evident with low dose exposure, as will be discussed in Chapter 4.

[17] Although a study of the history of homoeopathy has failed, so far, to turn up any evidence that Hahnemann was influenced by Paracelsus, he was a proponent of Bacon's work, and Bacon in turn rested his chemical philosophy to a certain extent on that of Paracelsus (Peltonen 1996, p.19,128).

[18] Originally printed in a paper entitled 'An Experiment Concerning a New Principle for Determining the Medicinal Powers of Drugs' in *Hufelands Journal*, 1796.

concepts that stand in the way of an understanding of multiple chemical sensitivity.[19] It is also provided because of the parallels between Hahnemann's work and that of Paracelsus, the first man dismissed by modern toxicology and the other revered for providing the discipline's basic tenet.

It was the shift in experimentation from humans to laboratory animals, and the introduction by MJB Orfila of quantitative methodology in the mid 1800s, that marked the beginning of the era of modern toxicology (Loomis & Hayes 1996, p.3). The stimulus for the development of toxicology over the last 100 years has been, on the one hand the advent of the synthetic chemical industries, and on the other the public reaction to their unwanted side effects, including those of pesticides. The 1920s to 1940s saw a dramatic upsurge in the field of toxicology, with the development of DDT, organophosphate insecticides and phenoxy herbicides, and mounting concerns about cancer and other chronic diseases (Rodricks 1992, p.42; Gallo & Doull 1991, p.6-7; Ballantyne *et al.* 1993, p.3). Then came the emergence of the new field of environmental toxicology, credited to the publication in 1962 of Rachel Carson's *Silent Spring* (Matsumura 1975, p.2; Ballantyne *et al.* 1993, p.4). Incidents such as the birth of thalidomide-deformed children and the industrial accidents at Seveso and Bhopal have added further impetus to the development of toxicology (Ballantyne *et al.* 1993, p.3).

Toxicological assessment has moved from its initial concern solely with acute toxicity on the target organism, be it human or insect, to a broader and more long-term assessment of effects on a wide variety of non-target species (Ballantyne *et al.* 1993, p.4). Cancer has become an important part of this refocusing. Nevertheless toxicology, particularly that which is involved in the regulation of pesticides, has been unable to catch up with the ever increasing understanding of the potential effects of chemicals on organisms. The assessment of effects of endocrine-disrupting pesticides, now reported by a number of scientists,[20] is not, to date, included in regulatory toxicology in any country, although the United States is working through this issue.[21] The Food Quality Protection Act (1996) and amendments to the Safe Drinking Water Act required the United States Environmental Protection Agency (US EPA) to develop a screening process for chemicals causing some types of endocrine disruption, namely that of oestrogen, androgen and

[19] Positive dose–response means that the greater the amount of a substance taken, the greater the effect. Conversely, the principle of homoeopathy is that the more a substance is diluted the greater its effect.
[20] See, for example, Colborn, vom Saal & Soto 1993; Colborn, Dumanoski & Myers 1996; Guillette, Gross, Masson, Matter, Percival & Woodward 1994; Soto, Chung & Sonnenschein 1994; Arnold, Klotz, Collins, Vonier, Guillette & McLachlan 1996; Hoyer, Grandjean, Jorgensen, Brock & Hartvig, 1998; Pickford & Morris 1999; Krimsky 2000.
[21] See, for example, Keller 1997; Safe, Connor, Ramamoorthy, Gaido & Maness 1997; Crisp, Clegg, Cooper, Wood, Anderson, Baetcke, Hoffmann, Morrow, Rodier, Schaeffer, Touart, Zeeman & Patel 1998.

thyroid hormones. A two volume report on the subject was produced in August 1998 (EDSTAC 1998). The importance of endocrine disruption to assessment by both the public and the technical experts should not be underestimated. Recent evidence that synthetic pyrethroids, such as are commonly used in household fly sprays, are hormone disruptors lends weight to the 'what else don't we know' attitude of the public, and the ensuing lack of trust in toxicology and government regulators (Go, Garey, Wolff & Pogo 1999). Synthetic pyrethroids have been, and still are, promoted as safe replacements for the more toxic organophosphates. Implications of the endocrine-disruption discoveries for pesticide policy is discussed further in Chapter 6, section 6.1.3.

Another issue of toxicology, that of the assessment of the synergistic effects of a mixture of chemicals (Lu 1996, p.64; Arnold *et al.* 1996) is even further from inclusion in the regulatory toxicology agenda, although a need for this is acknowledged by some, (e.g. P/CCRARM 1997). Because synergism is not currently included in regulatory toxicology, discussion of it will be held over to Chapter 4. For now it will merely be noted as a subject that is increasingly exciting comment, not only by public interest groups, but also by scientists themselves (e.g. Hansen, De Rosa, Pohl, Fay & Mumtaz 1998). It is noted here in the context of several of the previously cited definitions of risk that include reality as a factor in actual risk. For the reality of human existence is that people are exposed, not to a single chemical, but rather to a mixture of chemicals that may interact with each other to magnify the toxic effect.

3.4 Regulatory toxicology: the assessment of pesticides

Although legislated risk assessment is comparatively new in New Zealand, it dates back to the 1969 National Environmental Policy Act in the United States (Shrader-Frechette 1985, p.4) and the formation of the US EPA. Much of the material cited in this chapter is drawn from the American experience simply because it constitutes the bulk of published work. The regulatory assessment process used in New Zealand to date has not been described in the literature, nor is there publicly available information on procedures and criteria. It could be expected that under the HSNO Act, the new regulatory regime will provide more information. However, to date, there is little detailed information available on the actual toxicological assessment process that will be instituted. For this reason, the American system must largely be used here for the purpose of exposing the deficiencies of toxicological risk assessment of pesticides.

Modern risk assessment in toxicology relies on what Krimsky (1992, p.5) referred to as "hypothetico-deductive modelling of risk events" (p.5). In this process risk is regarded as

an objective phenomenon, amenable to measurement in terms of consequence and probability (Krimsky & Golding 1992a, p.355):

> Risk is a probabilistic statement, a statistical construct.
>
> Scala 1991, p.985.[22]

Regulatory risk assessment processes for pesticides involve four stages: the identification of hazard, the definition of dose-response models, the estimation of exposure, and the characterization of risk (Krieger & Ross 1993, p.566; US EPA 1990; Klaassen & Eaton 1991, p.37; van Leeuwen and Hermens 1995). Risk to both human health and to specific indicator species within the environment are subject to assessment. The following analysis focuses on human health risk assessment for illustrative purposes only. The risk a pesticide may pose to human health does not necessarily reflect the risk of that same substance to the environment, for reasons that include a greater sensitivity of some organisms to a given exposure than that demonstrated by humans, a more intense biological relationship with the environment, and a potentially greater ecosystem exposure (Johnston, Santillo & Stringer 1996, p.224). Environmental risk assessment, based on ecotoxicology and the physico-chemical properties of the substance, has become increasingly important as the regulatory process catches up with society's concern for the environment.

It should be noted that there is no apparent consistency in the use of the term 'hazard' by toxicologists: Klaassen & Eaton pointed out that:

> The term 'hazard' is frequently used interchangeably with 'intrinsic toxicity' in risk assessment guidelines (NAS, 1983), although some toxicologists have traditionally equated hazard with risk. Hazard has been defined as 'the likelihood that injury will occur in a given situation or setting' (Plaa 1989). Thus, hazard and risk are quite similar in meaning and include considerations of both intrinsic toxicity and the circumstances specific to exposure.
>
> Klaassen & Eaton 1991, p.37.[23]

Even the US EPA appears to demonstrate a lack of consistency in use of the term: in one document (US EPA 1990, p.20) it referred to hazard assessment as detailing the inherent toxicity regardless of the level of exposure, yet George Kowalczyk (1996) described the US EPA's Hazard Quotient as a ratio of exposure to toxicity, as "some indication of

[22] Dr Robert Scala, Senior Science Advisor, Exxon Biomedical Sciences, Inc., New Jersey, USA.
[23] Dr Curtis Klaassen, Professor of Pharmacology and Toxicology, University of Kansas, School of Medicine, Kansas City; Dr David Eaton, Associate Professor of Toxicology, University of Washington, Seattle.

whether a health risk may arise" (p.23-4).[24] David Lovell (1993) understood the term hazard to mean "the set of inherent properties of a chemical . . . which makes it capable of causing adverse effects in man or the environment when a particular degree of exposure occurs" (p.443).[25]

In this thesis, the term hazard is used to describe inherent toxicity, or the ability of a pesticide to cause structural or functional harm, as this appears to be the norm for pesticide regulatory toxicology (e.g. US EPA 1990; Krieger & Ross 1993; Cal/EPA 1996), although not necessarily for toxicologists (Ballantyne *et al.* 1993, p.7; Aldridge 1996, p.3,213).

3.4.1 Hazard identification

This part of the process is designed to identify the potential of a pesticide active ingredient to adversely affect health. It details the inherent toxicity of a pesticide regardless of exposure to it. The process usually involves administering to laboratory animals a range of doses of a pesticide well in excess of the amount that humans would ordinarily be exposed to.[26] Data from epidemiological studies on humans may also be incorporated, although such data is rarely available. Epidemiological studies are usually either cohort studies or case-control studies. In the former, indisputably exposed populations such as factory workers are compared, for disease incidence, with a matched non-exposed control group. In case-control studies, people in disease groups are selected and compared with non-diseased groups matched for age, race, gender, and lifestyle (Marquis 1989, p.159).

Typically, the test animals are weighted frequently, and observations made on their behaviour and the appearance of symptoms such as tremors or convulsions. Eventually the animals are dissected, their organs weighted and examined, and cell tissues examined (Stine & Brown 1996, p.2).

Test animals are monitored for specific adverse effects that routinely include acute toxicity, developmental toxicity, reproductive toxicity, genotoxicity, chronic toxicity and oncogenicity (Krieger & Ross 1993, p.567). The US EPA (1990, p.21) noted that hazard

[24] Kowalczyk, Dames & Moore, UK.
[25] Lovell, British Industrial Biological Research Association, Surrey, UK.
[26] Rats are used for most tests, with rabbits preferred for skin irritation tests and guinea pigs for allergenic sensitisation tests (ACVM Group 1998). Dogs and non-human primates may also be used for some chronic tests (van Leeuwen & Hermens 1995, p.152). *In vitro* toxicity tests have not yet replaced animal tests for these requirements, despite considerable concern about the ethical aspects of treating animals in this manner.

identification should include, as endpoints of concern, subclinical and preclinical adverse effects, although they did not specify what such effects might be.

Determination of carcinogenicity potential is a critical step in hazard identification, with two types generally recognised: genotoxicity, which causes irreversible self-replicating DNA damage (Kowalczyk 1996, p.18), and non-genotoxic carcinogenicity, which involves mechanisms such as promotion, peroxisome proliferation, hormone imbalance, and cytotoxicity leading to compensatory cell division (Hodgson & Levi 1996, p.98).

Table 3.1 New Zealand pesticide registration data requirements for new active ingredients, as at January 1998

Toxicology:

- acute toxicity (for both active ingredient and formulated product):
  - oral, dermal, inhalation
  - skin and eye irritation
  - skin sensitisation
- sub-chronic toxicity (90 days to 12 months)
- long-term toxicity (≥12 months)—chronic toxicity and oncogenicity
- reproductive toxicity
- developmental toxicity
- genotoxicity (mutagenicity)
- "additional studies", e.g:
  - studies of metabolites and impurities
  - toxicity of mixtures
  - other studies relevant to particular chemicals, such as neurotoxicity
- human toxicological data (content not specified)
- NOEL (no observed effect level)

- dermal absorption
- occupational exposure
- metabolism/toxicokinetic studies

Environmental toxicology:

- birds, mammals and other vertebrates (wild):
  - acute, short-term, special studies (e.g. chronic, reproduction)
- aquatic organisms (freshwater and marine):
  - acute, short-term, special studies (e.g. chronic early life-stage)
- non-target invertebrates, e.g. predators, parasites, bees, earthworms, soil micro-organisms [acute toxicity]
- non-target vegetation

- assessment of environmental hazard.

Additional requirements include residue and plant metabolism studies, chemistry, efficacy, mode of action, environmental chemistry and fate.

Source: ACVM Group 1998

Of the non-carcinogenic effects, neurotoxicity and teratogenicity are regarded as the most serious, according to Kowalczyk (1996, p.18), because irreversible damage can result.[27] However, neurotoxicity may be an optional extra in regulatory toxicology for pesticides. In New Zealand, at least, neurotoxicity data is not required for all new active ingredients (refer Table 3.1), nor is it required in Australia (Newman-Martin 1992, p.157). The decision to require special studies, such as neurotoxicity tests, appears to be made largely on the basis of the structure of the chemical and knowledge of effects of similar chemicals. Hence, neurotoxicity tests are required for all organophosphate insecticides, a group of chemicals known to affect the nervous system of humans, but are likely to be excluded for chemical groups not currently recognised as causing such effects.

3.4.2 Dose-response relationships

Closely associated with the identification of hazard, is the determination of the relationship between particular doses and the response to those doses—a necessity for predicting adverse effects on humans. In fact, Gots (1993) described the dose-response relationship as "the bedrock" (p.61) of toxicology, and Klaassen and Eaton (1991) described it as the "most fundamental and pervasive concept in toxicology" (p.18). The objective of this exercise is to arrive at a dose of the pesticide that will be 'acceptable' to humans, i.e. 'safe'.

The theory behind the use of high doses on laboratory animals is that if a high dose of a substance does not cause an adverse effect, then a low dose will not. This concept is known as a positive dose-response: as the dose increases so does the response. This assumption is directly attributable to Paracelsus' concept of the dose makes the poison. Although Paracelsus did not actually state a positive dose-response relationship as such, it is clear from his treatise *Third Defense* that this was his theory. Interestingly, his reasoning derived from his religious principles rather than from any statistically significant experimental data such as is required by modern toxicologists as demonstration of sound science:

[27] A teratogen increases structural or functional abnormalities in offspring if administered to either parent before conception, or the female parent during pregnancy, or directly into the developing organism.

> What is there in all that which God has created that is not blessed with goodness for the benefit of mankind. Why then should a poison be cast aside and condemned, since we are exploring not the poison itself but nature from whence it came.
>
> Paracelsus, cited in Deichmann *et al.* 1986, p.210.

Karen Stine and Thomas Brown expressed the modern toxicological version of the Paracelsian concept as follows:

> A basic principle of toxicology is that response varies proportionally to a geometric [1, 2, 4, 8, 16 mg/kg], not arithmetic [1, 2, 3, 4, 5 mg/kg], increase in dose.
>
> Stine & Brown 1996, p.4.[28]

The dose-response relationship is used to extrapolate the effects seen at high doses to predict those that will occur at low doses, and a number of mathematical models have been developed for this purpose (refer Table 3.2). This is because in order to achieve statistical significance over the required dose range, such a large number of animals are required for tests that the costs are regarded as being prohibitive (Scala 1991, p.990). One oft-cited study was carried out in the late 1970s for the purpose of direct observation of effects at low-dose exposure, with group sizes large enough to achieve statistical significance. Even so, the results of this study, the National Centre for Toxicological Research low-dose carcinogen study or the ED_{01} study, were ambiguous, and the sought after dose that produces liver cancer in 1 percent of animals (ED_{01}) eventually still had to be estimated (Scala 1991, p.990).

Table 3.2 Mathematical models used in risk extrapolation

Statistical or distribution models:

- Log-probit
- Mantel-Bryan
- Logit
- Weibull

Mechanistic Models:

- One-hit
- Gamma multihit (k-stage)
- Multistage (Armitage-Doll)
- Linearized multistage

[28] Stein, Associate Professor and Director of the Toxicology Program, Department of Biology/Toxicology, Ashland University, Ohio; Brown, Professor of Entomology, Clemson University, USA.

Stochastic two-stage (Moolgavkar-Venson-Knudson)
Source: Klaassen & Eaton 1991, p.39.

The LD_{50}

The most well-known dose-response relationship is that of the median lethal dose, or LD_{50}, which is used as a measure of acute toxicity. Its determination is one of the oldest toxicological processes, and it is still given a central role in both the assessment of pesticides, and the expression of their ability to cause harm. The LD_{50} is the predicted dose that will kill one half of an exposed population, and is arrived at by treating groups of uniform test animals, usually rats, with a geometric series of single doses of a pesticide. The highest dose given is usually that which kills 90 percent or more of the animals dosed within a short, specified time-period. Typically, only ten animals are exposed at each of six doses, with an additional untreated control group. Variation in response can occur as a result of some animals being very susceptible and some very tolerant, as well as from experimental error. Tolerance is assumed to be normally distributed. Plotting the accumulated percentage mortality against the logarithm of the dose gives rise to a sigmoid curve, regarded as a typical dose-response curve (Timbrell 1995, p.10). The LD_{50} is calculated by transforming the accumulated percentage mortality at each dose to a probit mortality score (Stine & Brown 1996, p.5,6).[29] The resultant dose-response curve, therefore, does not reflect individual response to doses, but rather it reflects a population response (Klaassen & Eaton 1991, p.19).

NOELs and LOELs

The Paracelsian approach to the dose-response relationship leads inevitably to the development of a threshold model, in which a threshold for safe exposure is established. This concept gives rise to the second dose-response relationship of note: a 'no observed effect level' (NOEL), which is the highest dose that causes no observable effect on the test subjects during toxicity tests.[30]

There may be some practical difficulties in establishing a NOEL relating to the number of dose levels with which to establish effects without causing excessive mortality or weight loss. If the NOEL is not established, it may be calculated from the lowest observed effect level (LOEL) by using a default factor of 1/10 (Krieger & Ross 1993, p.567). This is considered, according to Robert Krieger and John Ross (1993) to be "the reference point

[29] A probit is a unit of probability based on deviation from the mean of standard distribution.
[30] Sometimes referred to as a NOAEL, or no observed adverse effect level.

formally recognised as the toxicological threshold" (p.567).[31] Aldridge (1996 p.147) pointed out that a true threshold relates to a no-effect level *for a defined form* of toxicity, such as lethality, rather than to the generalized no-effect level used for regulatory toxicity.

The US EPA (1990) noted a "conceptual" problem with the threshold approach: the difficulty of "identifying 'safe' levels for diverse human populations, which are expected to have significant inter-individual variations in biological responses to toxicants" (p.22-3). It noted that neurodevelopmental effects are being observed at increasingly low levels of exposure to lead. There is also a division of scientific opinion as to the validity of thresholds for cancer. The EPA stated that:

> All carcinogens are now assumed to be biologically active even at the lowest doses, without thresholds. Thus there is no 'right' dose at which they are considered harmless.
>
> US EPA 1990, p.22.

Kowalczyk, however, stated in 1996 (p.18) that a threshold *is* assumed to exist for non-genotoxic carcinogenicity, although not for initiation of genotoxic activity. This divergence of opinion on such a fundamental scientific question can have a profound effect on the resulting risk estimations, as will be demonstrated in section 3.5.2. with respect to dioxin.

The NOEL is used to set exposure limits, in particular the Acceptable Daily Intake (ADI). This is the amount of pesticide that it is estimated can be ingested every day for life without causing adverse effect. According to John Timbrell (1995), the ADI "is determined by the use of a suitable safety factor which may be up to 1000, but is usually 100" (p.15): [32]

$$\text{ADI} = \frac{\text{NOEL}}{100}\ \text{mg/kg/day}$$

The US EPA makes use of Reference Doses (RfDs), similar in concept to ADIs, but which were developed to define 'acceptable' long-term exposure to a chemical, i.e. from seven years to a lifetime. These are also derived from NOELs and LOELs. Kowalczyk provided the following definition, from the US EPA, of a reference dose:

[31] Krieger, Jellinel, Scwartz & Connelly, Inc., Washington, DC; Ross, Department of Pesticide Regulation, California Environmental Protection Agency, Sacramento, USA.
[32] Timbrell, Glaxo Professor of Toxicology, School of Pharmacy, University of London, UK.

> The RfD is 'an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime'.
>
> Kowalczyk 1996, p.23.

Dose-responses of carcinogens

Another mathematical relationship may be used to describe the dose-response relationship of a pesticide's potential to induce the formation of tumours, or its oncogenic potential: Q star, or Q*. Q star represents the slope of the dose-response curve derived from animal tests. It represents the incidence of tumours divided by daily dosage of pesticide, and is used to predict tumour incidence at low dosage of pesticides (Krieger & Ross 1993, p.567).

For genotoxic carcinogens, it is assumed that there is no threshold for initiation of activity: the lowest exposure may cause a carcinogenic effect. Mathematical modelling on the basis of animal-derived data may be used to arrive at a Slope Factor, which is a measure of the increase of cancer risk with dosage. The Slope Factor is defined by the US EPA as "the plausible upper-bound estimate of the probability of a response per unit intake of chemical over a lifetime" (Kowalczyk 1996, p.22), and is usually expressed as increase in lifetime risk of cancer. The mathematical models used to establish risk estimates for genotoxic carcinogens provide for extrapolation from experimental data to low-dose exposures. The extrapolations may be linear, sublinear, or supralinear, depending on the likely mechanisms of carcinogenicity (Kowalczyk 1996, p.19). The US EPA has a default model called the Linearized Multi-Stage Model, which assumes chemical carcinogens mimic radiation.

No dose-response

Timbrell (1991) reported that "there is usually no dose-response relationship for immune responses, as the magnitude of the response is dependent on the type of reaction of the endogenous immune system, not on the concentration of the foreign compound" (p.257). Apart from this reference, the possibility of there being no mathematical relationship between dose and response is generally either excluded from, or denied in, toxicology texts and papers.

3.4.3 Exposure assessment

There are generally two different exposure pathways considered in regulatory toxicology: that of the occupationally exposed person, and that of the general populace

via the medium of food residues. The purpose of the assessments seems to be to ensure that use patterns for the pesticide do not result in 'excessive relative risk' for the 'maximally exposed individual'. It involves measuring, or estimating, the intensity, frequency and duration of human exposure. Use is made of monitoring data, including biological monitoring, and chemical transport and environmental fate models to calculate chemical intakes and likely effective doses at critical sites, such as organs.

Occupational exposure assessment is typically based on the maximally exposed adult, who is generally assumed to be exposed either through the manufacturing process or through application. One method of assessment involves the use of patch tests on the skin of applicators, which may be used to collect ambient levels of the pesticide over a fixed period. The other, more recently developed, method of exposure assessment is that of biomonitoring in which urine or blood samples are analysed for residues of the pesticide or its metabolites. Blood levels are regarded as the most accurate indicator of biological significance. Exposure assessment in the US regulatory model gives rise to an end point called the Chronic Daily Intake (Kowalczyk 1996, p.26). Krieger and Ross (1993, p.571) stated, with respect to the assessment model used, that "a critical series of usually unstated assumptions are operating to make the estimate *extremely uncertain* (but conservatively so)" [emphasis added]. These include the assumptions that the exposed person is a seventy kg male adult, who experiences thirty exposure days per year, has a forty-year working life, and has a life span of seventy years.

The other exposure pathway that is considered in regulatory toxicology is that of food residues. Here the end point that is derived is the Acceptable Daily Intake (ADI). The concept of ADI, according to Klaassen and Eaton (1991) was established by the World Health Organisation during the early 1960s. It was defined as "the daily intake of chemicals, which, during an entire lifetime, *appears* to be without *appreciable* risk on the basis of *all known facts at the time*" [emphasis added] (Klaassen & Eaton 1991, p.39). Note the qualifying words.

According to de Raat, Stevenson, Hakkert and van Hemmen, (1997), exposure risk assessment techniques are not needed for genotoxic carcinogens: since there is no threshold for initiation of activity, they are said to present a health risk at every exposure level.

3.4.4 Risk characterization

This final part of the process brings together hazard assessment, dose-response assessment and exposure assessment in what is known as risk characterization. Krieger and Ross (1993) noted that the important elements include "the relevance of the adverse

effects in animals to predicting harmful responses in humans, and the acceptability of uncertainty concerning hazards and dose-response relationships" (p.569). They also noted that "the relative nature of the characterization and the uncertainties involved in deriving it are not generally appreciated" (p.569).

Risk characterization, is "the primary vehicle for communicating health risk assessment findings" (P/CCRARM 1997, p.85). Krieger and Ross (1993) described it as "an extremely useful tool" with which to "convey levels of concern about particular chemicals" (p.570). It is contended that risk characterization is used rather to convey levels of *non-concern* about risk from chemicals and herein lies its usefulness to both regulators and the pesticide industry.

There are two primary approaches to conveying the 'levels of concern'. One approach is that of a quantitative mathematical estimate that includes standard criterion of causality and statistical significance (e.g. 95% confidence) and which results in Reference Doses, Benchmark doses and other quantitative outputs. The US EPA has two separate quantitative risk assessments, one for cancer and one for other chronic effects (Kowalczyk 1996, p.27):

- Cancer: for genotoxic carcinogenicity, risk is the product of Chronic Daily Intake and risk per unit of exposure given by the Slope Factor (Risk = CDI x SF).
- Other chronic effects: the calculated exposure is compared with the acceptable toxicological level by means of a Hazard Quotient. The Hazard Quotient is derived as a ratio of the Chronic Daily intake to the Chronic Reference Dose (HQ = CDI/RfD).

The second approach is that of the more qualitative "weight-of-evidence" determination of risk, which involves consideration of all relevant scientific information available, including assay results, epidemiology studies, metabolism and pharmacokinetics, mechanistic information, and structure-activity relationships (Klaassen & Eaton 1991, p.46). This may result in the inclusion of data that is regarded as biologically significant but not statistically significant, as may be the case with the occurrence of rare tumours (Brunk *et al.* 1998, p.42,51-2).

The quantitative approaches to risk characterization are finding increasing favour in some quarters with the development of new mathematical models and the refinement of others, such as the modified benchmark dose methodology for cancer risk assessment proposed by the Technical Working Party on Carcinogen Risk Assessment for Soil Contaminants (TWPCRASC 1996). Yet, in other quarters, more emphasis is being place

on the weight-of-evidence approach. The US Presidential/Congressional Commission on Risk Assessment and Risk Management concluded that:

> Many risk characterizations have relied primarily on mathematical estimates of risk to communicate risk assessment findings, often conveying an unwarranted sense of precision while failing to convey the range of scientific opinion. . . . Mathematical estimates are important and should be included, but qualitative information on the nature of adverse effects, the weight of the scientific evidence, and the risk assessment itself is likely to be most useful.
>
> P/CCRARM 1997, p.85.

3.5 Assumptions, uncertainties and judgements in risk assessment

> The uncertainties and assumptions inherent in quantitative risk assessment are profound.
>
> Klaassen & Eaton 1991, p.42.

Risk assessment of pesticides involves, in the words of Lovell (1993), "two major complications" (p.445): the difficulty of estimating an effect at low doses from the observed effects at high doses, and the transfer of conclusions from studies on rats to humans. 'Uncertainty factors', sometimes misleadingly referred to as 'safety factors', are applied to the data derived from animal tests in order to accommodate the assumptions inherent in these two processes. Klaassen and Eaton (1991) identified the selection of appropriate mathematical models as the third area of assumptions that, together with the first two, attract the greatest degree of controversy in risk assessment.

Another area of controversy, although perhaps viewed as such more so by the public and some medical doctors than by toxicologists, is that of extrapolating estimates for humans to include potential effects on the most sensitive humans. The need for some extrapolation for the latter situation is recognised by scientists and regulators, as demonstrated by their occasional use of an additional uncertainty factor of ten. This uncertainty factor is assumed to allow for pregnancy, foetal and nursing infant vulnerability, together with some ethnic, disease and age-related sensitivities. It fails to include any other causes of increased sensitivity to chemicals, excluding entirely the syndrome of multiple chemical sensitivity. This syndrome, and its relationship to regulatory toxicology, will be examined in the next chapter.

Other assumptions, judgements and opinions are involved throughout the risk assessment process and this section will attempt to delineate at least some of these. For

these assumptions and opinions, and the use of uncertainty factors to infer a degree of knowledge of effect on humans, underscore the difference between scientific opinion and public opinion, although they do not wholly account for that difference as has already been demonstrated in Chapter 2.

3.5.1 Uncertainty factors

The uncertainty factors used in regulatory risk assessment are default assumptions that take the place of real data when it is not available. They are arbitrarily applied rules of thumb that serve to bias data. As such, they are products of expert judgements rather than of quantitative processes such as uncertainty analysis. Nevertheless, they are used quantitatively, even though they do not represent uncertainty in a quantitative sense.

Table 3.3 shows the multiplication factors used by the US EPA to extrapolate animal toxicology data to humans in the establishment of Reference Doses. Although this table identifies a total uncertainty factor of 10,000, usually only a 100-fold factor is used: 10-fold for the difference between humans and test animals, and 10-fold for the differences in sensitivity among humans (Marquis 1989, p.160; Klaassen & Eaton 1991, p.38; Dourson, Felter & Robinson 1996, p.108).

Table 3.3 Uncertainty Factors

Factor	Conversion	Reason
1- 10	LOEL to NOEL	when a NOEL cannot be derived
10	subchronic to chronic	when only subchronic data available
10	animal data to human	to account for interspecies variation
10	human susceptibility	to account for sensitive groups, e.g. children, elderly.

Source: Kowalczyk 1996, p.24.

The use of the uncertainty factors involves a considerable degree of judgement and assumption of values. Kowalczyk (1996) noted that an additional 'modifying factor' may be applied "to reflect quantitative professional assessment of additional uncertainties in the critical study used in the entire data set that are not explicitly addressed by [uncertainty factors]" (p.24). Klaassen and Eaton (1991) also described the modifying factor and related this exercising of "professional judgement" to the fact that the terms 'safety' and 'acceptable' are so "value-laden" (p.39). Indeed, it seems that it is precisely to avoid recognition of the role of values in this part of the process that the concept of Reference Doses was developed. The change in terminology appears to provide a more objective approach, but in fact the difference between the traditional Acceptable Daily

Intake approach and calculation of Reference Doses is "essentially semantic", according to Klaassen and Eaton (1991, p.39). The Reference Dose is used in the same manner as the Acceptable Daily Intake, i.e. as an indication of the level of chemical that a toxicologist has estimated the average person can safely ingest.[33]

Ted Loomis and Wallace Hayes (1996) succinctly encapsulated the prevailing regulatory paradigm with respect to the usefulness of uncertainty factors:

> For any material and adverse effect, some dose concentration exists for man or animal below which this adverse effect will not appear. This biologically insignificant concentration can and should be set by use of a proper safety factor (uncertainty factor) and competent scientific judgement.
>
> Loomis & Hayes 1996, p.208.[34]

Yet, despite the aura of reassurance emanating from the words 'proper' and 'competent', the California EPA (Cal/EPA) Risk Assessment Advisory Committee found that "methodological and interpretational differences" had resulted in inconsistencies between Cal/EPA and the US EPA in their use of uncertainty factors (Cal/EPA 1996). Was one of the agencies not using the uncertainty factors 'properly' or 'competently'?

The Risk Assessment Advisory Committee noted that "there is currently a long-running debate in the profession about the use of these default assumptions, and their relation to policy" (Cal/EPA 1996). The use of uncertainty factors has its opponents and these can, for convenience, be divided into two groups that have completely contrasting views:

i. Those who believe that the uncertainty factors 'probably' under-represent risk to humans at low doses, because of the number of unknown variables involved in exposure and in reaction to chemicals. What about endocrine disruption, now widely recognised by many scientists as resulting from exposure to some pesticides, denied by others and still not included specifically in regulatory toxicology? How can anyone be sure all possible effects on human health are known and included? Weight is leant to this view by the denial of the existence of multiple chemical sensitivity by most, if not all, toxicologists with consequent

[33] This contention appears to be borne out by MfE's technical specification for regulations under the HSNO Act, in which it defines the following terms (MfE undated):
Acceptable Daily Exposure, ADE = (NOAEL or LOAEL)/Uncertainty factor
Reference Dose, RfD = (NOAEL or LOAEL)/Uncertainty factor. In other words, there is no difference.
[34] Loomis, University of Washington School of Medicine, Seattle; Hayes, Corporate Product Integrity, The Gillette Company, Boston, Massachusetts, USA.

failure to incorporate consideration of it into risk calculations. This view tends to be supported by lay risk assessors.

ii. Those who believe that the use of uncertainty factors results in the biasing of data in a conservative fashion, meaning that actual risk is in fact less than that arrived at by use of the default factors, and that as a consequence chemical exposure is over regulated. This view tends to be supported by technical risk assessors, regulators and the chemical industry: "most agencies that estimate these subthreshold doses recognize this increasing protectiveness as a limitation, and they combine several areas of uncertainty together within a single 10-fold value" (Dourson *et al.* 1996, p.109). Proponents of this view have made, in recent years, increasing efforts to prove that uncertainty factors are too conservative.[35] They have also made increasing efforts to replace them with other approaches, such as probabilistic models, physiologically-based pharmacokinetic models, and direct input of available human data.

It is important to note that even those who believe that uncertainty factors conservatively bias the data, do not do so with certainty. Dourson *et al.* (1996) referred to validation studies as demonstrating the uncertainty factors as *tending* to be protective, *in general*, of public health, and refer to doses as *likely* to be without adverse effects.[36] This could be re-worded to state that the 10-fold uncertainty factor is *not always* protective. In fact, Dourson *et al.* reported a study by Calabrese (1985) as finding that the 10-fold factor for human sensitivity protected 80-95 percent of the population or, in other words, did *not* protect up to 20 percent of the population. How the data is interpreted depends on the personal bias of the interpreter and the point to be proven. The relevance of the failure to protect 20 percent of the population becomes a policy question rather than a scientific question.

In the context of this uncertainty about uncertainty factors, comments by New Zealand's Ministry of Agriculture (MAF) take on an interesting perspective. The United States made a policy decision to incorporate an additional 10-fold uncertainty factor in the dietary assessment of two organophosphate insecticides, methyl parathion and azinphos methyl, as recent legislation required protection of children from risk of acute poisoning.[37] In response to calls for New Zealand to take similar action, MAF had this to say:

[35] Dourson *et al.* 1996 provided details of studies.
[36] Michael Dourson and Susan Felter, Toxicological Excellence for Risk Assessment; Denise Robinson, International Life Sciences Institute.
[37] Food Quality Protection Act 1996.

> The reasons for a lack of enthusiasm in adopting the extra safety factor are complex, but includes that an acceptable daily intake relates to a whole lifetime average exposure. The acceptable daily intake has always been considered to have sufficient safety factors used in its estimation to take into account the potentially higher exposures and sensitivities of children, the aged, and the infirm. There seems to be no scientific justification for believing that an extra safety factor is required.
>
> Reeve 1999, p.2.

The response can only be regarded as a political one when viewed against the background of the information and opinion about uncertainty factors that has been provided here. Yet, the opinion is presented as if it is scientific. It is also extremely misleading, in that it seeks to reassure on the basis of a whole lifetime average exposure. This, however, is not the basis of the US action: the basis is the vulnerability of children to one-off exposure to acutely toxic organophosphates, for which the lifetime exposure is of no relevance.

Extrapolation from high dose to low dose

A number of authors have raised serious concerns about the validity of extrapolating results from high dose tests to theoretical low dose exposures. In part, these concerns relate to the use of default factors: a Lowest Observed Effect Level (LOEL) may be used to derive a No Observed Effect Level (NOEL) by taking into account the characteristics of the dose-response relationship and the mechanism of toxicity. If the mechanistic data is not available, then a simple numerical factor, usually ten, is used as a default (Kowalczyk 1996, p.19). The question of whether or not the default factor of ten is an accurate reflection of reality is not resolved.

Significant concern also centres around the statistical relevance of the high dose test results because so few test animals and dose rates are used in practice. Frank Lu (1996) expressed the view that "in general, the precision of the LD_{50} is improved by increasing the number of animals per dose" (p.76), further noting that some investigators use forty to fifty animals per dose.[38] Yet Stine and Brown (1996) stated that typically only ten are used. The use of relatively low numbers of test animals in studies, along with only a few different dose rates, is dictated by financial cost rather than sound scientific practice. Lovell (1993) noted that smaller sample sizes produce higher NOELs, and that therefore "the investigator who uses insensitive designs with too few animals is 'rewarded' with a higher safe dose" (p.449). Increasing the number of animals used in the tests and improving the sensitivity of methods for detecting toxicity may find effects at lower

[38] Lu, consulting toxicologist in food additives, pesticides and environmental chemicals.

doses, and it is on this basis that Lovell (1993, p.449) questioned the prevailing notion that the NOEL should be regarded as a threshold below which a chemical does not produce toxic effects. Brunk *et al.* (1998, p.51) also noted this problem, in particular with respect to rare tumours that show up more clearly as the size of the test population is increased: failure to see rare tumours in a small test population does not mean that they do not occur. Klaassen and Eaton (1991) concluded that, on the basis of the standard bioassay design of two or three dose groups, "there is little biological justification to assume that the shape of the [dose-response] curve at high doses in test animals accurately reflects the shape at much lower doses in humans" (p.43).

There is a further, perhaps even more fundamental, problem with the extrapolation of high dose test results to low dose effects, and that lies with the assumption of a positive dose-response curve. That curve means that if an effect does not occur at a high dose, it is assumed to not occur at much lower doses. Such a situation may not always be the case: Lovell (1993) noted that "the methods of deactivation [of a chemical] occurring at high doses may be different from those operating at lower, more realistic dose levels" (p.447). This view is echoed by a number of other researchers, particularly in the field of endocrine disruption:

> In some cases a high dose may paradoxically cause less damage than a lower dose. In exploring the effects of much lower doses of DES, Fred vom Saal has found that the response increases with dose for a time and then, with even higher doses, begins to diminish. Vom Saal's dose-response curve looks like an inverted U. Its shape is profoundly important to the interaction between the endocrine system and synthetic contaminants. Neither linear nor always moving in the same direction, the inverted U seems characteristic of hormone systems and it means that they do not conform to the assumptions that underlie classical toxicology—that a biological response always increases with dose. It means that testing with very high doses will miss effects that would show up if the animal were given lower doses. The inverted U is another example of how the action of endocrine disruptors challenges prevailing notions about toxic chemicals. Extrapolation from high-dose tests to lower doses may in some cases seriously underestimate risks.
>
> Colborn *et al.* 1996, p.169-70.

Inverse dose-responses have also been found in levels of somatotrophin[39] and immune parameters[40] in laboratory rats exposed to the insecticide aldicarb. Additionally, low doses of a mixture of fifteen commonly used pesticides have been found to cause a

[39] Porter, Green, Debbink & Carlson 1993.

[40] Olson, Erickson, Hinsdill, Wyman, Porter, Binning, Bidgood & Nordheim 1987; Shiraz, Erickson, Hinsdill, & Wyman 1990.

significant increase in levels of 8-OH-2-deoxyguanosine in DNA, an indicator of oxidative damage mediated by free radicals and believed to result in cellular ageing and cancer (Lodovic, Aiolli, Monserrat, Dolara, Medica & Di Simplicio 1994). Higher doses did not cause this effect, but did result in reduced levels of the detoxification product benzo[a]pyrene hydroxylase and *N*-demethylase. The interpretation of these findings is that the higher doses of these pesticides caused a depression of the cellular mechanism resulting in an inhibition of the oxidative damage seen at low dose exposure. The authors of the study referred to the low doses they used as being "comparable to human exposure" (Lodovic *et al.* 1994, p.166).

The conclusion to be reached from these findings is that exposure to low doses of pesticides, such as may typify the human experience, may be more toxic than the higher doses used in laboratories to determine the supposed level of safety. When the scaling factors of extrapolation are added to this, there is a double distortion effect. Not only is the higher toxicity of the lower dose overlooked, but also the statistical results of the higher dose are mathematically reduced to provide estimates of the effects on humans at the lower doses normally experienced.

This finding of an inverse-dose relationship obviously challenges the notion of threshold doses, which are assumed in regulatory toxicology for noncarcinogenic effects of pesticides. Another challenge is provided with the suggestion, by a group of scientists, that there may not be any threshold for chemicals that act as hormone agonists when exposure to these occurs *in utero* (Anderson, Conolly, Faustman, Kavlock, Portier, Sheehan, Wier, & Ziese, 1999).[41] They pointed to changes in prostate size as one potential outcome of such exposure, noting that the assessment of risk would revolve around definitions of adversity with respect to prostate size. They then stated that "the issues surrounding altered distribution of normal characteristics in the population are complex, requiring both technical input about adversity and public policy input on the level of tolerance for changes in these distributions by the public" (p.636). Thus, they confirmed the roles of subjectivity and values in this aspect of risk assessment.

A similar comment on the role of societal values can be drawn from the work of Sheehan, Willingham, Gaylor, Bergeron and Crews (1999). Their study of red-eared slider turtles indicated that there is no apparent threshold for exogenous chemicals that share a common mechanism with endogenous chemicals. In this case, it was the turtles' endogenous oestrogen that was supplemented by nanograms of exogenous 17B-estradiol

[41] From Colorado State University, Chemical Industry Institute of Toxicology, University of Washington, US EPA, National Institute of Environmental Health Sciences, US Food and Drug Administration, SmithKline Beecham Pharmaceuticals, and California Environmental Protection Agency.

(E2). The result was sex reversal of presumptive males leading to an increased ratio of females to males. Their hypothesis that "no threshold dose is expected because endogenous estrogens are at a sufficiently high concentration to exceed the threshold for sex reversal" (p.157) was borne out. The policy, not science, question becomes whether or not the sex reversal is an adverse effect. The authors of the study argue that it is an adverse effect, because it may lead to declining populations of effected animal species. Whether or not a similar decline in the human population, in a reputedly overcrowded world, would be regarded as an adverse effect is a question of values best decided in a public policy context. Of course, declining populations is not the only relevant issue with respect to the human population. The possible shift of the balance of power within male-dominated societies, which may result from an increased female to male sex ratio, may prove to be more of a concern to many.

In summary then, the extrapolation of data resulting from high dose trials to low doses such as would be expected in natural circumstances, requires a number of judgements and assumptions to be made. These include the number of animals used in the tests and whether or not the resultant findings are statistically significant, the existence of a threshold below which no effect occurs, and the existence of a positive dose-response relationship. All of these judgements have been questioned by scientists, indicating that the decisions involving them are subjective. Recent scientific findings lend weight to the view that some of the assumptions may not be supportable. As Justice Stephen Breyer (1993) put it, "the critics are right, in that there is no consistent scientific rationale for assuming a linear relation between dose and response" (p.44), and that regulators may use these models "for reasons of mathematical convenience rather than science" (p.45).

Extrapolation from animals to humans

Equally controversial is the extrapolation of data gained from experiments on animals to risk estimates for humans. The applicability of such data to humans is affected by a number of factors. These include differences in life-span, genetic homogeneity, metabolic rates and pathways, bioavailability and toxicity mechanisms, body weight factors, and rates and routes of exposure (Kowalczyk 1996, p.19; Scala 1991, p.991). The result is uncertainty about the veracity of the assumptions on which the extrapolations are based.

One of the greatest concerns with the extrapolation of data from animals to humans relates to carcinogenesis. There is a considerable degree of belief, in scientific and regulatory circles, that laboratory tests designed to detect cancer in animals may not in fact provide a valid basis for extrapolation to humans. There are two reasons for this

view. Firstly, the occurrence of cancer in animals may differ from that in humans for reasons of genetic susceptibility or different physiological and metabolic processes, such as uptake, activation, detoxification and storage of pesticides. For example, the B6C3F1 strain of mice is regarded as being particularly prone to liver cancer when exposed to large doses of chemicals (Meijers, Swaen & Bloemen 1997, p.94). According to Meijers *et al.* (1997, p.94), this may be related to differences in "enzymology and cellular components of lung and liver" (p.94) between the mice on the one hand and other rodents and humans on the other. Renal tumours in the male rat are regarded as being of no relevance to cancer in humans, for the rat tumours are thought to be caused by the accumulation of alpha-2 microglobulin and this protein does not exist in humans (Albert 1994, p.82).

Secondly, the carcinogenic effects seen in animal tests may be a side effect of the testing method rather than of the chemical as it would ordinarily be experienced. Current toxicology tests require near toxic doses of pesticides to be used in order to identify cancer. The resulting cancer therefore may, or may not, be a neoplastic manifestation of a toxic reaction that caused cell death and chronic cell proliferation. Such a cancer may not be indicative for cancer risks at the lower doses that are, presumably, experienced by humans (Meijers *et al.* 1997, p.94).

The conclusions normally reached are that the predictive value of animal data for human cancers is very poor and that, because of the neoplastic effect and the susceptibility of the mouse strain, the extrapolation of the data to humans significantly overestimates the risk to the latter.[42] However, the corollary to this is that it may also significantly underestimate the risk, for the second conclusion is based on three assumptions. The first of these is that humans do not have any genetic or metabolic sensitivities that are greater than those of the rodent. The second assumption is that human exposure to the low doses of carcinogens that characterise real conditions, is less likely to cause cancer than high dose exposure under laboratory conditions, even for the same species. Note, however, the finding of Lodovic *et al*. (1994), reported in the preceding section, that low dose exposure to a mixture of pesticides resulted in increased free radicals in rat livers, which in turn are believed to lead to cancer. The third assumption is that the individual human is affected by only one potentially carcinogenic substance at any one time.[43] In

[42] Recall the findings, reported in Chapter 2, that approximately 50 percent of toxicologists surveyed by Slovic *et al*. (1997) thought animal reactions to chemicals to be a reliable indicator of human reactions, and 50 percent thought them to be unreliable. Similarly, only 50 percent thought that animal studies overestimate the risk of cancer to humans because animals are more cancer-prone, although 85 percent thought they overestimated the risk because of the cytotoxic effect of high doses.

[43] The survey of toxicologists by Slovic *et al*. (1997) found that 41 percent thought that animal tests underestimated the risk to humans because of synergistic effects of chemical mixtures.

other words, the effects of the concomitant exposure to a wide variety of environmental carcinogens together with psychological and other physiological stress factors that is the reality of human existence is ignored, along with the findings of Lodovic *et al.* (1994).

Also ignored, is the fact that toxicologists do not yet have perfect knowledge of the causations and mechanisms of cancer in humans. This last point is underscored by Ernest Hodgson and Patricia Levy:

> Even in metabolic studies in experimental animals the isozyme specificity for pesticides, whether they are acting as substrates, inhibitors, or inducers, is largely unknown. Further, in only a vanishingly small number of cases has the role of human isozymes in pesticide metabolism been examined.
>
> Hodgson & Levy 1996, p.97.[44]

The particular metabolic pathways that are of relevance to the question of carcinogenicity are those of activation and detoxification of xenobiotics in the liver, which involve cytochrome P450 mono-oxygenases. Cytochrome P450 is "a super family of heme-thiolate enzymes" (Lewis, Ioannides & Parke 1998, p.633). More than 750 members of this family have been characterized to date, in terms of gene sequence, but so far only thirty-six human P450s have been sequenced. According to Lewis *et al.* (1998), "it is generally recognized that induction of P450s associated with metabolic activity (e.g. CYP1A and CYP2E) is also regarded as indicative of potential toxicity/carcinogenicity" (p.633).[45] The problem is that there is considerable interspecies difference in xenobiotic metabolism involving P450 mono-oxygenases, traceable to "variations in their levels, their inducibilities, and the existence of different P450 isoforms of the same protein family or subfamily in various mammalian species" (Lewis *et al.* 1998, p.634):

> It can be argued that the use of small rodents as surrogates for humans is scientifically flawed due to fundamental differences in the metabolizing enzymes in the mammalian species. The <50% concordance between rat and mouse and between male and female in each species serves to diminish confidence in the rodent bioassay; there is also little correlation with human epidemiological studies for carcinogenicity.
>
> Lewis *et al.* 1998, p.635.

The conclusion that the animal data has poor predictive value for humans is not disputed, but the belief that the data therefore overestimates the risk to humans *is*

[44] Hodgson and Levi, Department of Toxicology, North Carolina State University.
[45] David Lewis, Costas Ioannides, and Dennis Parke, School of Biological Sciences, University of Surrey, Guildford.

disputed on the grounds of sheer uncertainty stemming from inadequate knowledge. Do the laboratory tests, using high dose exposure to single carcinogens, adequately identify the role of pesticides as promoters or initiators of cancer in humans exposed to low dose mixtures, especially those forms of cancer for which there may be a predisposing heritable gene defect in humans but not in rodents (Albert 1994, p.33)?

In order to account for the uncertainty concerning cancer and all other less-well studied health effects, an uncertainty factor of ten is used to extrapolate the data from animals to humans. Kowalczyk reported that the factor of ten is used because a comparison of dosage in terms of body weight and surface area has shown that 'man' receives a dose six times higher than that received by rats and nine times higher than that received by mouse:

> On this basis, dividing animal body weight doses by a factor of 10 is a justifiable means of equating toxic potency from rodents to man.
>
> Kowalczyk 1996, p.20.

He did not specify the conversion rate for 'woman' or 'child'. This is not a question of semantics: women and children have different body weight to surface area ratios to that of men, yet it is only that of men that is used in toxicology models. However, of greater importance is the highly questionable scientific validity of reducing all the extremely complex metabolic and genetic permutations of rodents and humans to a simple factor of ten, essentially by ignoring them completely.

Extrapolation to sensitive humans

> In an era in which we, as a society, are striving for racial and sexual equality, as well as sensitivity to the needs of the elderly and disabled, the prospect of achieving equal protection for all calls for sensitive scrutiny. . . . It follows logically that we should make a distinction for . . . groups that bear a disproportionate burden of risk because of an identifiable susceptibility.
>
> US EPA 1990, p.41.

The US EPA (1990) referred to two distinct groups of human sensitivity: that in which variations are predictable, and that in which increased susceptibility is "the 'random' variation in physiologic make-up that is inherent in all biological systems" (p.41).[46] They did not specify the factors underlying the variations they described as being 'random'. However, one such variation can be found in the expression of cytochrome P450, with

[46] Klaassen & Eaton (1991, p.38) also referred to "idiosyncrasies" as contributing to differential human sensitivity.

considerable interindividual differences occurring within ethnogeographical populations, as will be discussed below.

There tends to be more attention paid by toxicologists, however, to the predictable variations, which have been classified by the US EPA (1990, p.41-5) as follows:

Biologically based factors:

i. Pregnancy

- Sensitivity of the foetus to chemicals that can cross the placenta.
- Sensitivity of nursing infant's nervous system to chemicals in milk.

ii. Age

- Higher incidence of chronic disease in elderly.
- Children may be more susceptible to carcinogens with extended latency.
- Organ systems of children are undergoing development and are more susceptible than those of adults.

Socially based factors:

i. Lifestyle

- Alcohol enhances primary hepatotoxicity of some halogenated hydrocarbons.
- Cigarette smoking increases risk of cancer from exposure to substances such as radon, asbestos, and possibly arsenic.

ii. Socio-economic factors

- Groups relying heavily on fish are more susceptible to pollution of estuaries, coastal waters, etc.

Biochemical factors:

There are a number of biochemical factors affecting the individual person that can contribute to the variation in sensitivity to pesticides. To the extent that these biochemical variations are recognised, an effect may be predicted, but it cannot be assumed that all variations are recognized. These variations may involve genetic factors, nutritional factors or disease factors, and some examples cited in toxicology texts and regulatory documents are briefly described here.

i. Genetic

- Genetic factors may be ethnically distributed, such as with groups which are known to have a higher proportion of people with inherited serum alpha-1-antitrypsin deficiency. This deficiency increases a person's susceptibility to alveolar destruction and pulmonary emphysema resulting from chemical exposure (CAL/EPA 1996; P/CCRARM 1997). A deficiency of glutathione-*S*-transferase causes diminished detoxification of some carcinogens (P/CCRARM 1997).

- One of the genetic factors increasingly recognised by medical researchers, but not yet by toxicology texts and not included in the P/CCRARM list, is that of the inheritance of variant polymorphic genes that code the pesticide-metabolizing enzymes cytochrome P450, glutathione S-Transferases and the paraoxonases (Au, Sierra-Torres, Cajas-Salazar, Shipp & Legator 1999, p.501,504).[47] Expression of these genes varies throughout the population. Lewis *et al*. (1998, p.634-5) reported that expression of cytochrome P450 is affected by factors such as age, sex, diet, genetics, pathophysiological status, tissue specificity, prescription and recreational drug intake, and voluntary and involuntary exposure to toxic chemicals in the environment. Some clusters of favourable and unfavourable expressions have been identified. For example, according to Au *et al*. (1999, p.505), more senior citizens have a favourable expression of these genes, that is are better able to metabolize chemicals, as compared with a middle-aged population.[48] Recognition of the role of these enzymes, and variation in their expression, is important, for they influence the accuracy of the assessment of exposure, as will be discussed in the following section. They also influence the worth of epidemiological studies on occupationally exposed people, a problem that will be addressed in the Chapter 4. Further discussion of the involvement of these enzymes in detoxifying pesticides will also occur in Chapter 4, in the analysis of multiple chemical sensitivity, for deficiency in their expression is posited as one of the possible underlying factors for this condition.

ii. Medical

- Increased susceptibility may result from a chronic health condition: asthmatics are known to be more affected by air pollutants; coronary heart disease increases susceptibility to carbon monoxide; and chronic liver disease decreases the ability to detoxify chlorinated hydrocarbons and halogenated aromatics (US EPA 1990, p.42-3).

[47] William Au, Carlos Sierra-Torres, Nohelia Cajas-Salazar, Bryan Shipp, Marvin Legator, Department of Preventive Medicine and Community Health, The University of Texas Medical Branch, Galveston.
[48] This finding could be interrupted to mean that, in general, older people are less sensitive to the effects of pesticides. It could also mean that people who are more sensitive to pesticides, courtesy of the expression of these genes, do not live as long as those who are less sensitive. Au *et al*. cited El-Zein, Abdel-Rahman & Au 1998.

iii. Nutritional

- Nutritional status may affect sensitivity: deficiency of calcium, magnesium, iron, or protein increases absorption of dietary lead (US EPA 1990, p.44); deficiency of Vitamins A, C and E can increase susceptibility to polychlorinated biphenyls, chlorinated hydrocarbons, and pesticides (CAL/EPA 1996).

Klaassen and Eaton (1991) expressed the view that the uncertainty factor of ten used to take into account all these differences between humans "may be insufficient to protect the most susceptible individuals if idiosyncrasies are present" (p.38). Weight is added to this view by estimates that doses of pesticides that produced small deficits in neurological function in adult male healthy outbred rats ranged between 1.5 and 4 orders of magnitude (MacPhail 1997, p.455).[49] The rat findings indicate that, even without the idiosyncrasies of human variation, the default factor of ten is insufficient to cover the variation within rat populations. MacPhail commented that the addition of different ages, gender and physiological states would likely magnify that result, meaning that the traditional uncertainty factor of ten used as a default value for variation of sensitivity in humans in risk estimates "may be woefully inadequate" (p.455). Lewis *et al.* (1998) noted that laboratory rats "tend to be genetically pure strains, less subject to genetic variation, and maintained in a strictly controlled environment under specific dose regimens and dietary restrictions" (p.635). They concluded that this is another reason for the need for caution in extrapolating results from rodents to humans.

There is an additional factor that, it is suggested, may effect individual sensitivity to pesticides (Rea 1992; Rowat 1998), but which is not included in the P/CCRARM analysis, nor in the uncertainty factor: the existing body burden of chemicals. George Lucier and Arnold Schecter (1998) noted that body burdens of individual chemicals vary tremendously within the U.S. population, and that very little is known about them.[50] Major determinants of the variations are thought to be age, sex, occupation, lifestyle, diet, urban versus rural setting, accidental exposures, and social and cultural inequalities in environmental and occupational exposures (Lucier & Schecter 1998, p.625). Another determinant is how fast a person can metabolize a chemical and hence remove it from the body, and this is an expression of genetic variation as previously described. This subject will be discussed further in Chapter 4, for the impact of body burdens is that of a functional mixture of chemicals and also an issue of concern for multiple chemical sensitivity.

[49] MacPhail cited MacPhail & Glowa 1996.

[50] Lucier and Schecter, Environmental Toxicology Program, National Institute of Environmental Health Sciences, North Carolina.

In conclusion, it is important to note that extrapolations described in standard toxicology deal only with single-chemical-specific toxicological knowledge relating to observed effects. There is a myriad of reasons why the use of simple factors of ten, to extrapolate the effect of pesticides on rodents in laboratories to humans, is incapable of accurately reflecting the reality of human existence. The factors are not based on scientific rationale, but rather on cost and expediency, and applied as a matter of subjective judgement. This is one of the areas in which judgements need to be made that is most open to bias emanating from the value systems of the people involved. One or two less, or more, factors of ten, can make a significant difference to the ensuing risk estimates. It is necessary to be mindful that the use of uncertainty factors does not create certainty, or safety. It merely creates uncertainty with a false aura of safety. It obscures the lack of real knowledge about the actual effects of pesticides on humans.

3.5.2 Selection of data inputs and risk models

The selection of data inputs and mathematical risk models tends to excite less concern than does the extrapolation of the resulting test data to potential human experience. In part, this is because there is perceived to be a greater degree of scientific precision in this fundamental part of the process. That may be so, yet it is also riddled with choices and judgements and hence open to bias from assumptions based on underlying and implicit value systems.

Data inputs

The US EPA (1990, p.20) reported that the National Academy of Sciences has estimated there to be "at least 25 components—of both a scientific and *policy* nature—in complete hazard identification" [emphasis added].[51] Wherever policy decisions are required, the dominant values of the scientists involved, or their employers, influence that decision. Even when the same fundamental approach is taken to risk assessment, differences in scientific judgement and interpretation of data were found by the Risk Assessment Advisory Committee of the California EPA to result in substantial differences in risk estimates between Cal/EPA and the US EPA (Cal/EPA 1996).

Krieger and Ross (1993) referred to the need to "decide which effect and what level of severity will be treated as a 'response'" (p.567). With respect to the first of those two decision elements, de Raat *et al.* (1997, p.204) noted that "it is an illusion to think that all possible adverse effects can be detected with any practically and economically feasible toxicological data set" (p.204). With respect to the second decision, the US EPA (1990)

[51] US EPA cited NAS 1983.

noted the problem of "arriving at a judgement as to what the response means" (p.23), and asked the question "what is truly a valid indication of an untoward health effect?" (p.25). The decision to treat an effect as an adverse effect in part depends on statistical significance and knowledge of chemical structure and activity relationships, according to Krieger and Ross (1993, p.567).[52] It can be surmised from that, that a response other than those expected from a particular chemical structure may well be disregarded. Lewis *et al*. (1998, p.635) pointed out that the decision to determine whether or not a chemical is a carcinogen, in part depends on the site in which a tumour has occurred in trials: unusual or rare cancer sites tend to be given less weight than those that occur, for example, in the liver or kidney.

Such a judgement of expected effects from particular chemical structures also underlies the decision on whether or not to require a particular toxicity test in the first place. Commonly, this occurs with neurotoxicity tests as previously indicated. In deciding against a neurotoxicity test for a pesticide, on the basis of the structure of that chemical and its relationship to chemical groups not recognised as causing adverse neurotoxic effects, the door is closed against previously unrecognised chemical-effect relationships.

Even if the regulator decides that a neurotoxicity test is required, which one should it be? Fan, Howd and Davis (1995) asserted that "dozens of procedures to anaylze various nervous system functions have been developed over the last few decades to evaluate both acute and chronic effects of chemicals, but no comprehensive test battery has emerged as a standard" (p.347).

Quantification of dose-response relationships requires both a quantifiable method of measuring toxicity and a precise means of expressing it. There is a great variety of end points of toxicity that could be used. A mechanistic, molecular criterion is regarded as ideal by Klaassen and Eaton (1991), but usually not available. Instead, a measure of toxicity that is "unequivocal and clearly relevant" (p.19) is selected—such as the inhibition of cholinesterase by organophosphate insecticides. Klaassen and Eaton (1991) noted that "although many end points may be quantitative and precise, they are often indirect measures of toxicity" (p.19). This may result in the overlooking of other toxic effects that can be of greater significance but are less amenable to the requirements of the dose-response quantification model.

The selection of cholinesterase inhibition as a criterion illustrates this point well: the inhibition of cholinesterase by some organophosphates may not be directly related to the

[52] Krieger & Ross (1993) stated that government agencies provide guidelines for determining adverse effects and that this process utilises "well-tested methodology that is used virtually universally" (p.567).

main toxic effect of delayed neuropathy, according to Timbrell (1991, p.8). Symptoms of cholinesterase inhibition usually occur within a few minutes and may last several days. They commonly include tightness of the chest, wheezing, bradycardia, constriction of the pupil, salivation, lacrimation, sweating, nausea, vomiting, diarrhoea, fatigue, involuntary twitching, muscular weakness, hypertension, hyperglycaemia, tension, anxiety, ataxia, convulsions, coma, and in extreme cases death by respiratory failure. The effects of delayed neuropathy, however, which may not be manifested for ten to fourteen days, involve degeneration of peripheral nerves in the distal parts of the lower limbs, possibly spreading to upper limbs. The effects of the cholinesterase inhibition can be alleviated by treatment, but those of the neuropathy cannot (Timbrell 1991, p.327-30). Additionally, Rosenstock, Keifer, Daniell, McConnell and Claypoole (1991) found that a persistent decrease in neuropsychological performance followed acute poisoning by organophosphates, long after the acute symptoms had disappeared, and not related to cholinesterase levels.[53] More recently, Ahmed and Davies (1997) proposed the existence of a neuropsychiatric syndrome resulting from chronic exposure to organophosphates.[54] The symptoms include muscular aches and pains, influenza-like symptoms, personality change with affective destabilization, impulsive suicidal ideation, impairment of concentration and memory, language disorder, reduced tolerance to alcohol, heightened sense of smell, heightened sensitivity to organophosphates, deterioration of handwriting, and impaired tolerance of exercise. Therefore, the simplistic use of cholinesterase levels as a method of quantifying the effects of organophosphates would appear to be an inaccurate reflection of the true level of effects.

There are further implications for this in the NOEL relationship. Timbrell (1991, p.15) put the view that, where the toxicological reaction to a pesticide is a reversible reaction, a threshold may exist below which repeated or continuous low-dose exposure will have no measurable effect. However, where the reaction is irreversible, not only can a single exposure be sufficient to cause damage, but also repeated low level exposure can have a cumulative effect resulting in eventual toxicity. Timbrell (1991, p.15) again used the example of organophosphates to illustrate this problem. Organophosphate inhibition of cholinesterase enzymes can be irreversible and toxicity becomes apparent after about 50 percent inhibition has been achieved: if the cumulative effect outstrips the resynthesis of the enzymes toxicity occurs regardless of the size of the last-straw dose.

[53] Linda Rosenstock, Matthew Keifer and William Daniell, Occupational Medicine Program, University of Washington; Robert McConnell, Division of Occupational and Environmental Health, Mount Sinai School of Medicine; Keith Claypoole, Department of Psychiatry and Behavioural Sciences, University of Washington.
[54] Ahmed and Davies, Rydon House Acute Unit, Taunton, Somerset.

It is important to add that, although cholinesterase reactions may be used to quantify dose-response relationships, they may not be the sole data input for determining the toxicity of organophosphates. A variety of neurotoxicity tests may be used to determine the effect on the nervous system (NRC 1993, p.152). However, it appears these may be inadequate to accurately portray the effects of these pesticides on children. Recent papers have drawn attention to children's relatively greater vulnerability to these pesticides, compared with adults (e.g. Eskenazi, Bradman & Castorine 1999; Landrigan, Claudio, Markowitz, Berkowitz, Brenner, Romero, Wetmur, Matte, Gore, Godbold & Wolff 1999). That vulnerability stems from a lesser ability to detoxify chemicals,[55] and from the immaturity of neurological and immune systems, the development of which is easily disrupted, according to Landrigan *et al.* (1999, p.434).[56] Low dose exposure to organophosphates during the critical period of brain development may result in long-term neurochemical deficits and behavioural abnormalities, according to a number of studies reported by Landrigan *et al.* (1999) and Eskenazi *et al.* (1999). Landrigan *et al.* (1999, p.435) also reported that new US EPA guidelines designed to detect the effects of pesticides on children fail in this area because they do not test for functional effects of organophosphates on the nervous system, nor do they follow through from early exposure to establish the risk of development of neurological problems such as dementia, Parkinson's disease or amotropic lateral sclerosis later in life (Landrigan *et al.* 1999, p.434-5). The importance of functional effects will be referred to again, in Chapter 4, in the discussion on low dose exposure to mixtures of chemicals.

One last aspect of data input that deserves scrutiny is the method used to obtain that data. Considerable doubts exist about the veracity of data obtained from various methods used to determine carcinogenicity. Long-term rodent trials have been the traditional test for carcinogenicity but, partly because of the escalating cost of these trials and partly because of doubts about applicability to humans, the Ames test for bacterial mutagenicity is increasingly used as a guide to the genotoxic nature of a particular chemical. Unfortunately, the concordance between this test and the rodent bioassay averages about 55 percent, and in one study was less than 40 percent, according to Lewis *et al*. (1998, p.636).[57] Nevertheless, the authors stated this test has been generally adopted because of its low cost and straight-forwardness. Computer generated results

[55] Landrigan *et al*. 1999 (p.434) cited Bearer 1995; Mortensen, Chanda, Hooper & Padilla 1996.
[56] Philip Landrigan, Luz Claudio, Steven Markowitz, Gertrud Berkowitz, Barbara Brenner, Harry Romero, James Godbold, Mary Wolff, Mount Sinai School of Medicine, New York; James Wetmur, Centre for Biology of Natural Systems, City University of New York; Thomas Matte, Center for Urban Epidemiologic Studies of the New York Academy of Medicine; Andrea Gore, Borikuen Neighbourhood Health Center, New York.
[57] Lewis *et al*. cited Bogen 1995.

of carcinogenicity tests, based on quantitative structure-activity relationship studies, are also a problem. They can, according to Lewis *et al*. (1998) be misleading in terms of overinterpretation of inadequate or insufficient data in certain circumstances. Lewis *et al*. (1998) commented that "the normally wide variation and margins of error in the biological data are usually disregarded in the search for apparently highly significant correlations" (p.637). Other authors also stressed that biological activity data is often overlooked because of the focus on structural descriptors and statistical significance.[58]

Risk models

Both mathematical models and conceptual models may be involved in the prediction of hazard and exposure. Kowalczyk (1996, p.22) noted the controversy over the use of these models, as a result of the vastly differing orders of magnitude of risk derived from the same data but with the use of different models. Klaassen and Eaton (1991) also noted that various models can predict widely different potential risks at low doses, and that therefore "model selection can be as important as the actual experimental data in the ultimate risk analysis" (p.43). This view is reinforced by regulatory experience, for the Risk Assessment Advisory Committee of the California EPA (Cal/EPA 1996) stated that "significant differences in the final products of similar risk assessments between Cal/EPA and federal agencies occasionally occurred and usually reflected different treatment of data sets rather than use of different or new data" (p.59). Scala stated that:

> The scientific debate rages without end about the extent to which each of these models fit the available experimental data. Particularly at low-dose levels for relatively weak-acting agents, some models show considerable insensitivity to the data and can diverge from actual risk (where known) by one to three or more orders of magnitude.
>
> Scala 1991, p.991.

Dioxin risk estimation is one of the most well known examples of model-determined risk estimation. Eleven estimates of risk from the 2,3,7,8-TCDD form of dioxin were made by the US regulatory authorities during the 1980s, all based on the assumption of no threshold and on an identical intake. They varied from 1.3×10^{-3} to 7.7×10^{-18}, a difference of 1.7×10^{14} in the resulting risk estimates (Beck, Calabrese & Anderson 1989; Kowalczyk 1996, p.22).[59] Altering one of the initial assumptions, as the Canadian government did by regarding dioxin as being not genotoxic, resulted in a threshold value 15,000 times

[58] Lewis *et al*. cited Benigni & Giuliani 1994; Benigni & Richard 1996.

[59] These are the exact numbers provided by the authors. There appears to be an error in one of the numbers; nevertheless the point is made about the huge difference in estimates.

higher than that set by the US EPA. Kowalczyk (1996) provided the reminder that "it is important therefore to remember the variability and imprecision that are inherent in dose-response estimates for carcinogens even when genotoxicity is not disputed" (p.23). A similar example was reported by Wildavsky and Levenson (1995, p.265), in which the estimates of the probability of an individual getting cancer from eating food containing residues of the fumigant ethylene dibromide varied over a million times depending on the model used.[60]

Wildavsky and Levenson (1995) noted that extrapolation models used in cancer risk assessment actually "combine two models in one: first, a model underlying cancer causation; second, the statistical approximation of that model" (p.262). The problems inherent in statistical approximation are magnified if the model does not well describe cancer causation in humans. They illustrated this problem with respect to the multistage model, concluding that "there is little reason to believe that they actually capture the biological process of cancer formation" (p.263). They also reported US EPA official Elizabeth Anderson as stating that "most often there is no biological justification to support the choice of any one model to describe actual risk" (p.262-3).[61]

Cancer risk assessment models essentially assume that the risk to children and the risk to adults are identical, for they make no differentiation. However, a challenge to that assumption was provided by the recognition of children's disproportional sensitivity to pesticides in a report by the USA's National Research Council, *Pesticides in the Diets of Infants and Children* (NRC 1993), and by an earlier one from the British Medical Association, *The BMA Guide to Pesticides, Chemicals and Health* (Morgan 1992). That sensitivity results, in part, from differing metabolic pathways, a lesser ability to detoxify xenobiotics, immature immune systems, and more time in which to develop chronic disease that may be initiated by early exposures (Landrigan *et al.* 1999).[62] The USA's political decision to require that special protection be afforded children resulted in the passage, in 1996, of the Food Quality Protection Act (FQPA). This was followed in 1997 by the White House Executive Order 13045 Protection of Children from Environmental Health Risks and Safety Risks, reflecting "a growing emphasis on well-recognized differences in the exposures, metabolism, and disease responses of infants and children

[60] Aaron Wildavsky, Professor of Political Science and Public Policy, University of California, Berkeley; Leo Levenson, student of Wildavsky.
[61] Citation incompletely given: Anderson *et al*. Quantitative Approaches in Use to Assess Cancer Risk, p.282.
[62] The authors took their information from NRC 1993 and a variety of papers.

to chemical exposures", according to Patricia Buffler and Amy Kyle (1999, p.A286).[63] The authors commented that:

> Risk assessment methods for carcinogens have not considered the timing of doses of carcinogens during a human lifetime. Models used to estimate dose and response do not consider the age at which doses are applied. A given dose of a carcinogen counts the same at 70 years of age as it does at 5. Because there is considerable evidence that doses received earlier in life are more likely to result in development of cancer than doses received late in life, this approach would be expected to underestimate risks of doses received during childhood.
>
> Buffler & Kyle 1999, p.A287.

It would be reasonable to assume from these statements that cancer risk assessment is the most 'uncertain' type of risk assessment that is carried out on pesticides, because of the lack of knowledge of cancer-causing mechanisms in humans. However, a US Congressional Research Report dispels that view with the following statement:

> The most detailed and well-established assessments at EPA probably are those used to assess human cancer risks of chemicals. . . . Other categories of risks, such as developmental or immunotoxicity, are rarely assessed.
>
> Schierow 1998, p.6.

If cancer risk assessment is regarded on the one hand as "little better than guesswork" (Wildavsky & Levenson 1995, p.265), but on the other as the most well established assessment process, it is difficult to know how to describe assessment of risks to the other toxicological endpoints already described.

This problem rapidly elevates risk assessment to the policy arena, and begs a reply to the following comment:

> If epidemiology is too insensitive and animal cancer tests are invalid, the question remains: How should the multitudes of chemicals be treated until we possess the knowledge to eliminate or restrict those that cause human cancers at low doses?
>
> Wildavsky & Levenson 1995, p.265.

The partial answer to that question is that the decision is a public policy one, not a scientific matter. In other words, first decide the grounds upon which pesticide policy should be established, and then the answer will become clear. As has been pointed out already, the USA's decision to recognise some degree of extra sensitivity of children to

[63] Buffler and Kyle, School of Public Health, University of California, Berkeley.

pesticides was a political one, not a scientific one. Hence, it could be argued that any decision like New Zealand's recent one NOT to recognise that sensitivity is also a political decision, not a scientific one. In New Zealand, at least, that decision has been taken by the toxicologist who registers pesticides, under the guise of science and in a manner which excluded the public policy process.

3.5.3 Uncertainties in exposure assessment

> Exposure assessments . . . are based on measurements, models, and assumptions, and generally focus on individual chemicals, media, and sources. Often, unvalidated mathematical models are used to make predictions about a population's exposure on the basis of limited information on chemical contamination and assumptions about the population.
>
> P/CCRARM 1997, p.73.

As discussed in section 3.4.3, occupational exposure assessment usually involves the use of patch tests on the skin of applicators, or biomonitoring of urine or blood samples for residues. The outcomes of both types of measurements are subjected to various modelling techniques to derive an estimated level of exposure. Use of these models involves a number of assumptions, such as how much of the pesticide is absorbed through the skin into the blood stream, or about the metabolism of the chemical that allows a correlation to be made between levels in the urine and levels in the blood. There are other decisions to be made too, such as whether or not to average short-term exposure levels over an individual's lifetime if the pesticide concerned is cumulative and carcinogenic, and whether or not to assume that the applicator is wearing the recommended protective clothing. Such issues would seem to be straightforward, but the decision that is made may be highly influenced by the underlying value system of the decision-maker and in particular, as Brunk *et al.* (1998) have noted, whether there is an inclination to protect health or to protect economic values.

The outcome of these decisions and assumptions may lead to dramatically varying estimates of exposure, as was illustrated by Brunk *et al.* (1998) in the Canadian alachlor investigation. In the course of this investigation, three separate exposure estimates were arrived at—by the Health Protection Branch of the Ministry of Agriculture, by Monsanto Canada Inc, and by the Alachlor Review Board—of which one pointed to a significant risk of cancer and the other two pointed to no risk at all (Table 3.4).

Table 3.4 Estimated farm applicator exposure to alachlor

Health Protection Branch	2.7 mg/kg
Review Board	0.001-0.0001 mg/kg
Monsanto	0.000031-0.0000009 mg/kg

Source: Brunk *et al.* 1998, p.59.

The reasons for these vastly different estimates lie in the assumptions and choices of methods employed by each organization, and these are summarised in Table 3.5.

In the face of inadequate and inconclusive data, the overwhelmingly decisive input into the exposure calculation was, according to Brunk *et al.* (1998, p.60), the value systems of the organisations concerned. Those value systems guided and determined the choices that were made at every step of the way, most especially the assumption or otherwise of a threshold for carcinogenesis. Whereas the Health Protection Branch set out to look at the worst-case scenario, and the Review Board sort the most reliable estimate, "each of Monsanto's assumptions worked to decrease the calculated risk of alachlor's carcinogenicity" (Brunk *et al.* 1998, p.66).

Table 3.5 Assumptions leading to different exposure estimates for alachlor

Health Protection Branch

- Used data from skin patch tests.
- Assumed not all farmers wear protective clothing, and gloves can fail, therefore 75% of body surface exposed.
- Assumed 100% of alachlor deposited on skin is absorbed into blood stream, a worst-case assumption in the absence of reliable data.

- Assumed there is no threshold for carcinogenic response to alachlor. They regarded the raw data as inconclusive, arguing that the lack of observed effects at low doses does not mean that there are not effects in practice, the lack of observed effect possibly being only a function of small sample size. Therefore, they assumed that one exposure could cause cancer.

Review Board
- Used data from biomonitoring (urine).
- But also assumed a 25% dermal absorption rate for patch tests.
- Assumed closed system application, full protective clothing, and no accidents occur.
- Assumed threshold carcinogenicity, therefore used full amortisation and varying rates of exposure.

Monsanto
- Used data from biomonitoring (urine).
- In the absence of a known transfer ratio from monkeys to humans, they assumed that monkey metabolism is sufficiently similar to humans to allow direct transfer of a correction factor for the urinary excretion value. They assumed, therefore, that the amount of alachlor in urine is 88% of the total body dose.
- Assumed it is unfair to penalise the company if farmers fail to wear recommended clothing, therefore calculated exposure on the basis of a closed application system, full protective clothing and no accidents.
- Assumed, on the basis of the sparse data available, that a threshold existed below which cancer could not occur. Therefore, they used full amortisation, the calculation of average daily exposure from the intermittent exposures that a fully protected applicator would receive.
- Assumed 1 day exposure per year at the rate of 4 pounds per/acre, 100 acres/year, 40 years of application and a life span of 70 years.

Source: Brunk *et al.* 1998, p.59-61,65-8,85-8.

Biomonitoring is increasingly finding favour with regulators and pesticide proprietors as a preferred indicator of exposure. In part, this is because of a view that risk estimates based on the patch-tested maximally exposed individual are too conservatively biased. Hence, the models overestimate the exposure risk to the public, and consequently may unnecessarily restrict use of the pesticide, causing diminished economic benefits. Underlying this view is the assumption that if the pesticide's level of risk is deemed 'acceptable' for the applicator then it will automatically be acceptable for the assumed less-exposed public (e.g. Guillebeau 1994, p.175). There are, however, several reasons why this may not, in fact, be the case:

i. The person who is occupationally exposed generally has protective clothing and possibly a respirator, at least in countries in which exposure assessment is carried out. The alachlor example showed that this is not always the case, but it may be

the basis for regulatory decisions. The public do not wear such protective clothing and, in instances of repeated, close-quarter spray drift, it is conceivable that a person may in fact inhale more of the chemical than the chemical worker. In certain spray drift situations topographical and/or climatic factors can result in unprotected exposure to a concentrated cloud of drift. Such an instance occurred with Jim Rea, organic avocado grower of Northland, who arrived home to find that a concentrated cloud of organophosphate insecticide had drifted down the valley, in which his property was situated, and settled in his house. The applicator of the insecticide was in a helicopter well above and isolated from the drift. Rea was significantly adversely affected by this exposure and remained unwell for a prolonged period following it.[64]

ii. The person who is occupationally exposed to pesticides in the course of manufacture may well be exposed to only one, or at most several structurally-related pesticides. However, the spray drift victim may be exposed to a medley of chemicals over time. Toxicological texts all acknowledge the potential effects of mixtures of chemicals. These effects may simply be additive, as is assumed to be the case for the occupationally exposed person. But the drift victim's medley of chemicals may instead be synergistic, with the overall toxic response being greater than the sum of the individual responses (Arnold *et al.* 1996). Or the effects may involve potentiation, a process in which two chemicals together exert effects that are entirely different from those of either chemical alone (Timbrell 1991, p.9,10). Regulatory toxicology assumes exposure to be to only one chemical. The issue of chemical mixtures will be explored further in the next chapter.

iii. Cullen, Pace and Redlich (1992) commented that "exposure backgrounds with low levels of chemical exposure appear, paradoxically, more likely to be associated with MCS [multiple chemical sensitivity] than do high-exposure settings" (p.18).[65] This may be because chemically sensitive people are unlikely to have placed themselves in an occupational situation involving handling of chemicals. Alternatively, or additionally, the explanation for Cullen *et al.*'s clinical experiences might lie with the observation of Lovell (1993, p.477) that the methods of deactivation occurring at high doses may be different from those operating at lower levels, and the previously-mentioned observations of inverse-dose responses by Olson *et al.* (1987), Shiraz *et al.* (1990), Porter *et al.* (1993), Lodovic *et al.* (1994), and Colborn *et al.* (1996).

[64] Based on personal communication with Rea over a period of time.

[65] Mark Cullen, Patricia Pace, and Carrie Redlich, Yale Occupational and Environmental Medicine Program, Yale University School of Medicine, New Haven, Connecticut.

> Cullen *et al.*'s clinical experience is supported by comments by Au *et al*. (1999) regarding the "well-documented 'healthy worker effect'" (p.505).[66] The documentation shows that workers with exposure to hazardous agents have an overall lower mortality rate than the general population. Au *et al*. (1999) proposed that this effect may be a result of "unrecognized occupational selection pressure against genetically susceptible individuals" (p.501). They were referring to inheritance of "unfavourable" alleles of the polymorphic genes responsible for metabolizing chemicals" (p.501). In their study of twenty Costa Rican farmers, they found significantly fewer with the unfavourable alleles than in the control group of workers not exposed to pesticides, thus leading them to hypothesize about the selection of a relatively "resistant" work force (p.505).

There are immense difficulties involved in adequately assessing public exposure to a pesticide, for there is a vast degree of variability in factors affecting that exposure. People consume differing amounts of fruit and vegetables, and they inhale differing volumes of air depending on their level of activity or exercise. They come into contact with differing quantities of soil, again depending on recreational activity but also on occupational activity, and they drink differing amounts of water depending on climate, exercise and physiological need (P/CCRARM 1997, p.89). All of these media may contain pesticide residues. To provide accurate quantitative exposure data is impossible, for the permutations of pesticide intake through food, water, air and soil is infinite. Assessment of exposure, therefore, requires the standardising of factors through the employment of a number of assumptions about dietary intake and body size. These assumptions generally include one that children and adult receive the same exposure. But this is challenged by Buffler and Kyle (1999), who noted that "because children are typically engaged in more physical activity, play close to the ground, and engage in characteristic hand-to-mouth behaviour, they are exposed to higher levels of toxicants such as pesticides" (p.A287). Additionally, their air intake at rest is twice that of an adult under the same conditions. The authors noted that the data needed for exposure assessments for infants and children is "seriously lacking":

> We have no evidence to suggest that exposure standards based on assumptions about adult toxicity, susceptibility, and exposure will adequately protect infants and children. Quite the contrary, there is sufficient evidence for some agents to believe they may not.
>
> Buffler & Kyle 1999, p.A288.

[66] They cited Howe, Chiarelli & Lindsay 1988, and Thomas, Winter & Donaldson 1997.

Typically, regulatory exposure assessment for the public focuses on food and drinking water, but does not consider all the potential exposure routes for each pesticide, which may include airborne dust, home garden use, household fumigation and carpet treatment, household aerosol insecticides, and pet insecticides, as well as drift from other pesticide users. Eskenazi, Bradman and Castonia (1999) noted the importance of these exposure routes, especially for children and the clear lack of information on actual exposure via these routes.[67] The USA's Food Quality Protection Act 1996 provides an improvement with the requirement for estimates of aggregate, cumulative, and combined exposures to pesticides (P/CCRARM 1997), with special attention paid to children. New Zealand's proposed regulations under the HSNO Act provide for the setting of Tolerable Exposure Limits (TELs) for a pesticide in each media. The TELs will be based on what is determined, through use of toxicological data, to be 'acceptable' exposure to a pesticide for people living under "normal circumstances", and what is estimated to be potential exposure through the media of air, soil, water and food (MfE undated, p.8).[68] Scant data exist for the actual concentrations of pesticides in these media in New Zealand, so the estimations will largely be guesswork.

A further gap between reality and estimate may arise because much of the human exposure may occur via inhalation or dermal contact, or both together, whereas many of the animal tests are carried out by administering the pesticide by either interperitoneal or oral means. US EPA scientists Whalan and Pettigrew remarked, in 1998, that "we lack coherent animal and human data bases for doing route-to-route extrapolations" (p.3). They illustrated this problem with the observation that two organophosphate insecticides—mevinphos and methyl parathion—are equally toxic by the oral route but, when inhaled, mevinphos is 130 times more toxic than parathion.

> These examples [sic] demonstrate how reliance on mixed-route data can dangerously undermine a risk characterisation. Because absorption across the respiratory mucosa tends to be far greater and more rapid than by oral and dermal routes, inhalation MOEs [margins of exposure] based on NOELs from these other routes will most likely underestimate the hazard, even as much as several orders of magnitude. The danger lies in not knowing the extent of the error.
>
> Whalan & Pettigrew 1998, p.5.

[67] Brenda Eskenazi, Asa Bradman, and Rosemary Castorina, Center for Children's Environmental Health Research, School of Public Health, University of California, Berkeley.

[68] "Normal circumstances" is defined as "living in compliance with present New Zealand laws and adopting a reasonably expected pattern of day to day living" (MfE undated, p.9). The definition is designed to apply the TELs to the 'average' way of living only. Thus, anyone living within the law but with an unusual pattern of day to day living may not be 'protected' by the TELs.

Lucier and Schecter (1998, p.625) noted that the same amount of exposure may result in different body burdens of chemicals. This is, in part, because children often detoxify chemicals at rates that differ significantly to those of adults. Additionally, women often detoxify chemicals at different rates to men. Add to this the differences in expression of the polymorphic chemical-metabolizing genes which cause some people to be slow metabolizers and some to be faster, and the result is a widely differing length of time over which individual people retain chemicals in their bodies. Hence, the same amount of exposure to a chemical may result in very different body burdens of that chemical (Lucier & Schecter 1998, p.625).

In summary, Krieger and Ross (1993) noted that "dissimilar circumstances, and the use of assumed values in the absence of data may substantially weaken conclusions, obscure critical exposure pathways and reduce confidence in the regulatory process" (p.569). Yet this does not stop the authors making the bald statement that "most exposures to chemicals that occur as a consequence of pesticide use are of no apparent biological significance" (p.569). Having thus dismissed exposure to pesticides as of no consequence, they then underscore their value judgements with the rather astounding likening of such exposures to the "aromas of morning coffee, freshly baked bread and newly mown hay" (p.569).

3.5.4 Risk characterization

Undue faith in the risk assessment process can sometimes lead those in the field to inappropriately describe the reference dose, arrived at by the risk characterization process, as "a safe dose level" (Fan *et al.* 1995, p.344). The reference dose is a quantitative method of characterising risk, and as such it is particularly susceptible to the vagaries in data and the interpretation of that data that have been described in preceding sections.

Brunk *et al.* (1998) referred to the quantitative approach as that of conservative science, and that of the weight of evidence approach as that of liberal science, noting that the choice of approaches "has a significant effect on the calculated risk and is thus not only a scientific but a social policy decision" (p.38). They illustrated this point with respect to the Canadian Health Protection Board's decision to ban alachlor and Monsanto's appeal against that ban. The Board, using a weight of evidence approach in the absence of good statistical data, found that there was biologically significant development of rare carcinogenic tumours. Monsanto, using a quantitative methodology, found the rare tumours to be of no significance.

3.6 Subjectivity in scientific risk assessment

> The risk assessment process, by its very nature, is a series of judgements.
>
> Cal/EPA 1996, p.23.

Gallo and Doull (1991, p.3) referred to toxicology as both a science and an art. The science is embodied in the observational and data-gathering phases, but the art lies in the use of this data to predict the likelihood of adverse effects. The preceding analysis has teased out the assessment process for pesticides, drawing attention to the significant number of instances in which judgements must be made in the absence of data. In so doing, it has demonstrated that the risk assessment process is highly subjective, perhaps even more art than science. Brunk *et al.* (1998, p.34) pointed out that in the 1989 Canadian alachlor banning episode the only objective scientific facts in the entire case were the incidence of tumours in rats under particular dose rates. Nothing more. That is still the situation for regulatory toxicology: the only scientific facts are the adverse effects on laboratory animals at specific dose rates and, as noted previously, even these are surrounded by subjectivity in terms of the delimiting of what effects are observed and how they are evaluated. Ulrick Beck (1992) charged that only those hazards that are regarded as being manageable are selected for inclusion in risk assessment processes in general. Additional scientific facts may be added to the process from the results of biomonitoring. But how these very few facts are converted to risk assessments for humans is fraught with uncertainty, lack of knowledge, estimations, mathematical models, judgements and consequently considerable inter-scientific differences of opinion, those differences arising not from errors of fact but rather from differences in assumptions.

A recent development in risk assessment has been the increasing replacement of the uncertainty, or default, factors with derived data and mathematical models, primarily to reduce the perceived conservatism of the risk assessments resulting from the use of those factors. It is informative to note some of the comments contained in documents supporting this new approach, for they would seem to endorse the public's concern about the ability of regulators to provide surety of safety. The following comments were contained in a draft guidance document, which issued forth from the Australian government's Technical Working Party on Carcinogen Risk Assessment for Soil Contaminants (TWPCRASC 1996):

> Due care should be taken to describe uncertainties and to avoid giving the perception of accuracy.
>
> p.xiii.

> [Traditional] threshold and no-threshold methods, however, are likely to be unduly influenced by the selection of doses.
>
> p.7.
>
> Risks estimated at doses below the range of experimental data can vary considerably depending on the model used, even though the various mathematical models used generally fit the experimental data equally well.
>
> p.8.
>
> The numerical expression of the calculated level of risk falsely gives the impression that it represents an exact measure of actual risk.
>
> TWPCRASC 1996, p.8.[69]

Whether or not a chemical provides a risk depends in part upon exposure to that chemical, and estimations of exposure are a major source of uncertainty, assumptions and hence hidden values. In the alachlor case, Brunk *et al.* (1998, p.59) found that the assumptions about the nature of exposure had a profound influence on the resulting estimation of risk: estimates ranged from 2.7mg/kg to 0.0000009mg/kg, the former based on a worst-case exposure scenario, and the latter on 'perfect' practice.

Yet, despite these uncertainties, the faith placed by some toxicologists in the regulatory model is so profound that it sometimes leads them to claim that a certain level of exposure to a pesticide *cannot* cause adverse effects. For example, New Zealand toxicologist Sue Thomas stated unequivocally that the Acceptable Daily Intake (ADI), a figure derived from acute toxicity data, "states a unique value for a substance that humans can be exposed to without toxic effect occurring" (Thomas 1998, p.4). She then stated that a Maximum Exposure Level (MEL) for spray drift, based on an ADI, will "ensure that a toxic effect does not occur from involuntary exposure" (p.8). It is important to review these statements within the context of the qualifying words used by the World Health Organisation, and reported earlier in this chapter, in its definition of ADI as "the daily intake of chemicals, which, during an entire lifetime, *appears* to be without *appreciable* risk on the basis of *all known facts at the time*" [emphasis added] (Klaassen & Eaton 1991, p.39). The World Health Organisation's statement is more truthful than its subsequent reinterpretation for policy purposes.

[69] The document was labelled draft, for consultation, and not for quoting. Yet, for some purposes, draft documents can be more informative than the final version, for they may reveal the value systems and the bare truths that become 'tidied up' for public consumption. Such a thing was found to occur with the New Zealand Ministry for the Environment's proposals for controls on spray drift. The first draft (Thomas 1998) promised safety, whereas the second draft (MfE 1998) did not, although the actual proposal remained essentially unchanged. The word 'safety' had been removed, but the value judgements of the institution presumably had not.

In short, the risk assessment of pesticides is fraught with uncertainty. Supporters of the process frequently write that methods are improving all the time, the discipline is evolving rapidly. But they also write that "a consensus on genetic risk assessment is not yet in view (Fan *et al*. 1995, p.355), that "risk assessors do not yet interpret such data in a consistent way" (p.348), referring here to the range of effects that may be observed in animal feeding trials. They refer to the "current uncertainties in scientific knowledge and lack of guidance for interpretation of immunological data" (p.350). How the likely effect of all these uncertainties on public health is interpreted depends entirely on the interpreter's reference point, his/her value system. That of Fan *et al*. would appear to be economic efficiency:

> The many uncertainties in the risk assessment process may result in the restriction of chemical usage to unnecessarily low levels—an inefficient use of resources.
>
> Fan *et al.* 1995, p.343.

3.6.1 Value frameworks

> The value judgements of all involved in risk assessment and risk decisions have a strong effect on their nature, character, and outcomes. The value-laden approach is used widely in making risk decisions without much acknowledgement.
>
> Cothern 1996, p.43.

> Moral values are present in all phases of risk assessment—including its motives, purposes, definitions, methods, and assumptions.
>
> Nash 1996, p.196.

That value frameworks play a role in decision-making by scientists now seems indisputable (Freudenburg 1996; Cothern 1996; Baker 1996; Nash 1996; Putzrath 1996; Sharpe 1996). Recall from Chapter 2 the difference in perception of risk from pesticides by male and female toxicologists: this difference results from differing worldviews. When there is uncertainty, judgements have to be made, and whenever judgements have to be made, no matter by whom or in what circumstances, those judgements evolve from that person's or institution's underlying value system. Hence, those made in a scientific context are as prone to bias as those made by the lay person. Values are inculcated in risk assessment at every step of the way: how risk is defined and the problem structured, what toxicological parameters are judged salient, what assumptions are made about fate, transport, exposure, and receptor behaviour, which methods are used for handling uncertainty, how much data is gathered, what assumptions are made about future land uses, which models are selected for use in estimating risk, how to handle cumulative effects, which data sources are used, etc. Richard Cothern of the US EPA stated that the

development of the low-dose effects "paradigm", that of a linear dose-response with no threshold for effect, is based on a value judgement (1996, p.41). Even the choice of form in which the risk assessment information is framed for the decision-maker is a subjective, value-laden process the outcome of which can have a strong influence on the resulting decision (Slovic 1997, p.65; Brunk *et al.* 1998, p.22). The US Congressional Research Service also noted this problem in its report to Congress in 1998:

> Thus, controversy will not disappear when risk analysis matures, because it grows inevitably from value judgements based on different ethical systems and inference choices embodied in agencies' science policies which make risk assessment possible as well as from the special interests that stakeholders have in EPA's risk estimates.
>
> Scheriow 1998, p.31.

Yet those values are never made explicit: they are not made available to the public for societal deliberation. All policy-making requires a consideration of values, yet somehow those values embedded in the risk assessment process have become sacrosanct, the property of the "expert", and the resultant risk-based decision-making is based on narrowly constructed views that cannot be assumed to be representative of the views of society as a whole.

The inextricable link between value systems and the outcome of technical risk assessments can be demonstrated by selecting only one small facet of that assessment process, the selection of the dose level at which an adverse effect occurs. Lovell (1993) noted that the US EPA's definition of NOEL is not one of 'no observed effects'. Rather, it defines it as "the exposure level at which there are no statistically significant increases in frequency or severity of effects between the exposed population and its appropriate control" (Lovell 1993, p.448). Lovell then argued that "defining whether a statistically significant increase is a biologically important finding is a subjective decision, partly determined by the choice of statistical test used" (p.448). It is also routed deeply in the value system of the person/agency/corporation concerned, as Brunk *et al.* (1998, p.41-2) demonstrated with respect to the decisions surrounding the banning of the herbicide alachlor. In this case, the choice was whether or not to regard as biologically significant effects that were not statistically significant in small sample sizes. Where the value system was protective of health (Health Protection Board) biological significance was given credence, but where the value system was protective of economic rationale (Monsanto) then only the statistical nonsignificance was acknowledged.

Brunk *et al.* (1998, p.32) identified three critical areas in which values permeate the assessment of risks relating to pesticides, and in particular the analysis of data:

i. The assignment of the burden of proof to safety rather than risk: in other words, it is not required that safety be proved but rather the easier test that 'significant' risk does not exist.

ii The standards of scientific rigor. If the standard criterion of causality (5 percent confidence) is applied, rather than the less rigorous weight-of-evidence criterion, then if a causal relationship is not established the outcome is that risks are assumed to not exist. What cannot be established with scientific rigour is regarded as being not credible (p.140).

iii. The attitude to risk itself: either that of risk-taking or risk-aversion. Since, in the presence of uncertainty risk cannot be accurately identified, it must be estimated. The estimator attempts to be accurate but automatically invokes a judgement to guard against over- or under-estimating the risks, in so doing achieving the opposite, i.e. the risk-taker guards against over-estimating the risks, and the risk-aversive guards against underestimating the risk. A risk-taker assigns the burden of proof to the risk-aversive to prove the chemical is unsafe, and the risk-aversive assigns the burden of proof to the risk-taker to prove it is safe (p.141-2).

Brunk *et al.* (1998, p.142) concluded that professional risk analysts are risk-takers and community spokespeople are risk-cautious, on the basis of the values they identified as framing the alachlor case, and which indeed appear to frame pesticide regulatory decisions generally. These values they regard as being assumed and conceptually linked to the risk-taking bias of risk analysis. These values are erroneously assumed by their adherents to be neutral, and it is the failure to recognise their non-neutrality that is, in Brunk *et al.*'s view (1998), the cause of "the stalemate in the technological debates of our day" (p.149). These values are:

i. A classical liberal conception of society with its bias against government interference, and with its concern for the freedom of individuals and of chemical companies to market their products (p.139). From this evolves a willingness to trade risks to human health for economic benefit, the classic cost-benefit trade-off. This in turn leads to a view that evidence of risk must be sufficiently compelling before measures are taken to protect public interests such as health (p.72): the burden of proof rests with establishing the chemical is not safe. Liberalism assumes that economic well-being is the goal that people wish to pursue regardless of the path by which it is pursued. It ignores other goals to which people may instead aspire.

ii. A positive view of the role of technology, in particular the tacit endorsement of the unrestricted use of pesticides in agriculture. Brunk *et al.* (1998, p.136) referred to the presupposition that technology is a benign tool for easing the burden of existence as 'familiar', 'respectable', 'dating back to the Enlightenment', and therefore assumed to be correct. In Brunk *et al.*'s view (1998, p.139), a pro-technology bias leads to the assumption that to exploit a technology is *prima facie* sound unless otherwise proven, thus again placing the burden of proof on 'safety'. There is a bias towards benefits, which establishes a mind-set in favour of the pesticide (p.143).

iii. An instrumental, utilitarian conception of the nature of rationality (p.72,143). There are two aspects to this. One involves restricting the conception of risk and benefits to only those that are supposedly fact-like and quantifiable, such as the risk of carcinogenicity and economic benefit, ignoring all other risks and benefits that could conceivably be regarded as subjective, thus maintaining an illusion of objectivity and neutrality. The other aspect is that of rationality occurring only if an action is instrumental in producing benefits, in particular in maximising the net benefit. In so doing, it ignores distributive justice and 'rights' claims (p.127), such as the right of a neighbour not to be contaminated with spray drift. It ignores the problem of one set of people bearing the risks and another reaping the benefits, and of voluntary risk being more acceptable than involuntary risks (p.144). To be rational in this sense means maximising net expected utility, which implies a risk-taking stance.

Brunk *et al.* (1998) asserted that, "in making judgements on the basis of inconclusive data, analysts are naturally motivated to protect whatever they value most" (p.35): if that be the use of chemical technology then the benefit of the doubt will be given to the pesticide. They concluded that, in the Canadian alachlor case, if the values underlying the assumptions (and hence the assumptions themselves) are stripped from the process, the estimate of exposure can be no more precise than that it lies in the range 2.7 to 0.0000009 mg/kg and either does or does not constitute a risk of cancer, depending on whether the value system was based on protecting human health, or on protecting economic interests (p.104).

The influence of values on the outcome of a risk assessment was also illustrated by Deborah Mayo in her analysis of the now famous US EPA formaldehyde review case.[70] During the Bush administration the US EPA had determined that "there may be a

[70] Mayo, Associate Professor of Philosophy, Virginia Polytechnic Institute.

reasonable basis to conclude that formaldehyde presents a significant risk of widespread harm to humans from cancer" (US Congress 1982, p.5-6, cited in Mayo 1991, p.262). However, with the advent of the Reagan administration, the government mood changed to one of "antiregulation" (Mayo 1991, p.263), a mood that resulted in a second reassessment. This one determined that:

> There does not appear to be any relationship, based on the existing data base on humans, between exposure [to formaldehyde] and cancer. Real risk could be considered to be low on such a basis.
>
> US Congress 1982, p.260, cited in Mayo 1991, p.263.

Although there were several factors involved in this change of decision, it appears that a crucial factor was the relative emphasis given to retrospective epidemiological studies on humans and to rat studies in laboratories. Where the first decision resulted from a conservative approach that placed greater weight on the statistically significant increases in nasal cancer in treated rats, the second decision, based on an antiregulatory value system, placed greater weight on the negative human epidemiological studies (Mayo 1991, p.262-3).

Graham, Green, and Roberts's (1988) analysis of formaldehyde studies also illustrated the vital role of values in the outcome of a cancer risk assessment. They referred to the dilemma regarding evaluation of two different types of cancer, adenomas and squamous cell carcinoma:

> It is conservative to combine the two types of tumours, but this approach may grossly inflate the actual human cancer risk. To ignore the benign tumour data is to run the risk of underestimating actual human risk.
>
> Graham *et al*. 1998, p.170.

The decision to combine the tumour types or ignore the benign tumour data in the end depends on which values are to be protected, economic or health.

3.7 The socialising of risk: acceptable to whom?

> A thing is safe if its risks are judged to be acceptable.
>
> Lowrance 1976, p.8.

> Acceptable levels in this sense are the retreat lines of a civilization supplying itself in surplus with pollutants and toxic substances. The really rather obvious demand for non-poisoning is rejected as *utopian*. At the same time, the bit of poisoning being set down becomes *normality*. It disappears behind acceptable values. Acceptable values make possible a *permanent ration of collective standardized poisoning*.
>
> Beck 1992, p.65.

Risk assessment assumes a permissible level of poisoning, in Beck's words. The decision about what that level is, i.e. whether or not a risk is acceptable, traditionally lies outside the risk assessment process, forming part of the wider 'risk management' process. Determining acceptability is regarded as a political decision, a value-based decision, and hence is separated from the 'purely scientific' process of risk assessment. Thus, it does not theoretically form part of this chapter, but brief mention will be made of it here because the notion that risk assessment is purely scientific has been rejected, hence the separation is regarded as a false one. Additionally, lay assessment of risks quite obviously includes deciding whether or not the risks are acceptable. And it is frequently the technical experts who make the decisions about acceptability. For example ERMA, which has no representatives of the community or of societal values, will alone make the decision on whether or not risks from pesticides are acceptable.

There are two general approaches: the delineation of a particular level of risk as acceptable, and/or the acceptance of risks if they are outweighed by the economic benefits attendant upon them (Guillebeau 1994; Barnard 1996). In these processes political decisions are taken for society to accept a certain level of risk from exposure to pesticides, in exchange for a perceived higher level of benefit usually regarded as being economic benefit (e.g. Barnard 1996).

The concept of acceptable risk would appear to arise from the very old common law principal of *de minimus*, in which the law need not concern itself with trivial harms (Margolis 1996, p.147). The US EPA uses '1 in a million' as the standard for the acceptable risk of developing 'excess' cancer, i.e. those over and above the background level of cancer than can be expected from other causes. The U.S. Supreme Court reputedly concluded that a 1 in a billion risk of cancer "clearly could not be considered significant", but that "a reasonable person might well consider" a one in a thousand risk to be significant—hence, in between, 1 in a million. Roy Albert (1994) reported that the EPA standard for acceptable risk of cancer was developed during "a hallway conversation", not on the basis of rigorous scientific analysis, but rather on the basis of what the public accepts as the risk of getting killed in a mass transportation accident and because it has "a nice ring" to it. As Shrader-Frechette (1991, p.71-72) pointed out,

the *de minimus* approach relates to the average person not the individual person, whereas most civil rights are based on the individual person's needs. It means that the elderly, children, persons with previous exposure to carcinogens, those with allergies, etc, face risks higher than those that are deemed acceptable on the basis of averages, without of course giving their consent.

Increasingly common, however, is the risk-benefit approach to determining acceptability of risks, which has been enshrined in some recent legislation such as New Zealand's HSNO Act 1995, and the USA's Safe Drinking Water Act Amendments 1996. Essentially, if the assessed benefit outweighs the assessed risk and cost, then the pesticide will be registered. The HSNO regime has two riders to this: if the risks are regarded as being unacceptable regardless of benefit the registration is declined, or if they are regarded as being negligible then benefits do not have to be proven (ERMA 1998, p.20). A similar approach is taken by the US EPA (Guillebeau 1994, p.175).

The major issue is who determines what is acceptable? It is usually the regulators, the technical experts, making decisions on behalf of society. But if the decisions are made by those with technical expertise and a technological rationality, how can they be expected to reflect the degree to which the risk may be acceptable to the wider public operating on a basis of social rationality? Brunk *et al.* (1998, p.116,134-136) drew attention to the narrow, instrumental conception of rationality applied by the Canadian Review Board in the Alachlor case, in which the adjudging of risks and benefits assumed, without question, the need for chemicals in agriculture and therefore excluded any consideration of the benefits of not using herbicides, which would obviate the need for any risks at all. Sweden is one of the very few countries that do include the ethic of alternatives in their risk analysis processes, as will be discussed in Chapter 5. In a similar vein, Wildavsky (1988, p.49-50) defended the acceptability of imposing some 'small' risks in order to reduce overall larger risks. He illustrated this hypothesis with an account of the number of lives lost to a particular drug versus the larger number of lives saved by that drug. In so doing he ignored the possibility of alternatives to that drug. What if no lives at all need be lost, by not using the drug and instead using another management approach? The availability of alternatives is an important issue in discussing the acceptability of risks from pesticides: what if there are less hazardous methods of achieving the same pest control outcome? What does this do to the level of acceptability of risk? In the majority of the pesticide regulatory systems around the world, risks from pesticides are adjudged in a vacuum through failure to provide risk comparisons with other effective management options, such as organic or biodynamic growing systems, or less hazardous pesticides. Yet the public

intuitively makes such comparisons and hence, frequently, the risks acceptable to the public are lower than those narrowly adjudged by the authorities.

There are a whole raft of social justice issues that are bound up in the decisions about the acceptability of risks. They include informed consent, the effects on those who are not average, and distributive justice. They will not be further discussed here for they have all been well traversed in other literature (e.g. Shrader-Frechette 1991). It will simply be noted that the acceptability of risk is not simply a question of economic and technical rationalisation: it is a question of social justice, and as such must be made in a manner that incorporates the views of wider society.

Conclusion

In conclusion, this chapter has demonstrated that risk, as assessed by technical experts, is not a fact. Nor is hazard a fact. "What is the sound of one fact speaking?" asked Professor William Freudenburg (1996, p.12) at a symposium on environmental risk decision-making. Perhaps one answer might be: risk assessment of pesticides. What Freudenburg was referring to is the 'fact' that all facts must be interpreted in order to be used: a fact does not self-interpret, and the interpretation of facts involves the value systems of the person interpreting them. However, as has been demonstrated, a more literal interpretation of Freudenburg's question may be applied to risk assessment in which the only fact is the effect of particular dose rates on particular laboratory animals, under particular conditions. That singular set of facts is bounded by discretionary judgements, or inference options, up to fifty of which may occur in a normal risk assessment process, according to Mayo (1991, p.257).[71]

As has been shown, those judgements involve value systems, and it is contended that failure to acknowledge these and their influence undermines the claim to objective rationality:

> Determinations of risk oddly straddle the distinction between objective and value dimensions. They do not assert moral standards openly, but in the form of a *quantitative, theoretical and causal implicit morality*. Correspondingly, in the investigation of risks with a generally conventional understanding of science, a kind of 'objectified causal morality' is being undertaken.
>
> Beck 1992, p.176.

[71] Mayo cited NAS 1983.

Risk assessment of pesticides is an essentially political process. It is "'science' only in an attenuated sense", according to Brunk *et al.* (1998) "notwithstanding the fact that it is typically carried out by scientists, including highly qualified ones" (p.3). Nevertheless, it is presented to policy makers and to the public as a scientific process.

The analysis in this chapter has demonstrated that the risk assessment of pesticides is not an exercise in what the 'naïve positivist' regards as scientific objectivity, but that it is a scientific exercise imbued with subjectivity arising from a lack of data and the vagaries of human reality. It is not the intention to use this analysis as a confirmation of the view of social reductionists, that risk is a social construct, and therefore does not exist in fact. Risks are real in that they exist, but the magnitude or acceptability of those risks cannot be determined as factual: they can only be estimated, assessed or perceived. The method used to assess those risks does not make them real or factual, it simply makes them assessed by a particular methodology, be it scientific, cultural, social, etc. Shrader-Frechette (1991) referred to all risk assessments as "risk perceptions". Whether the outcomes of the lay and technical assessment processes be titled risk perception or risk assessment is immaterial, but the attribution of one term to one group of people and the other to the second group cannot be justified. Fischhoff *et al.* noted the fallibility of expert judgement as a result of judgement biases, particularly where assessment of risks requires the expert to:

> . . . go beyond the limits of available data and convert their incomplete knowledge into judgements useable by risk assessors. In doing so they fall back on intuitive processes much like those of lay people.
>
> Fischhoff *et al.* 1981, p.33.

They offered some "anecdotal evidence" that experts display the same degree of "insensitivity to the tenuousness of the assumptions upon which beliefs are based" (p.35) as does the lay person. In other words, like the lay person, the expert may be overconfident in the "quality of their own judgement" (p.35). Such appears to be the case with the following comment from three authors, two of whom worked for the Department of Pesticide Regulation of the California Environmental Protection Agency:

> Possible acute effects of chemicals have been effectively regulated by health professionals including toxicologists during the past 50yr.
>
> Krieger, Ross & Thongsinthusak 1992, p.5.

This is an astonishing comment given the information available on acute poisonings from pesticides, and is given the lie by recent US moves to curb use of organophosphate insecticides because of the risks they pose to health. Some of these risks relate to potential acute effects on children from their consumption of food containing

organophosphate residues, as mentioned earlier (Reeve 1999, p.1). Yet those same authors, just one year before the National Research Council (NRC 1993) report that drew attention to this problem, passed the judgement that levels of residues in food and water are so low that they should not be called residues at all, but rather "be regarded as part of our chemical environment" (Krieger *et al*. 1992, p.3). It was two of these authors, Krieger and Ross (1993), who also likened exposure to pesticides as akin to the "aromas of morning coffee, freshly baked bread and newly mown hay" (p.569), as reported earlier in this chapter. These attempts to confer an unwarranted and erroneous degree of naturalness upon pesticide residues in food, air and water would appear to stem from a belief in the benignity and beneficence of chemical technology rather than from scientific *fact*.

The current elevation of risk analysis and risk assessment to a status of technological elitism effectively removes it from the ambit of the lay person, and hence accords it a protection from public scrutiny of the uncertainties involved, and of the value systems that underpin the consequent judgements and assumptions. The crucial concern for the public, and hence pesticide policy, is whether or not these values accurately reflect those of society as a whole. Public scrutiny of the process might well result in rejection of the whole model because of an inability to accurately reflect society's need. Where technocratic decision-making is afforded political legitimacy and the lay/societal view is discredited as false perceptions, democracy suffers. In policy terms, the results of risk assessment are often presented in a manner that infers that the risks a substance poses to humans and the environment are negligible, acceptable or tolerable. Such an approach assumes that society has defined the risks in the same way as has the assessor. However, this is very obviously often not the case. Such an approach also assumes that toxicology accurately measures all hazards pesticides may pose. On the basis of the factors of uncertainty, assumed to overestimate hazard, the effects of a pesticide as estimated by a regulatory model are assumed to be worse that any likely occurrence in real life (Margolis 1996, p.160). Thus, if a pesticide clears the regulatory risk assessment process, the assumption is that it is very unlikely to cause harm in real life, barring some accident or gross misuse. In practice, however, that 'unlikely' becomes a 'cannot' because the benefit of the doubt is given to the regulatory model and the scientifically derived risk, rather than to actual human experience. Evidence was presented in this chapter about the recent uncovering of the endocrine disrupting effects of some pesticides, not previously addressed by regulatory toxicology. The next chapter will provide evidence of other areas in which it fails to take into account hazards to human health.

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Chapter 4 The Failure of Risk Assessment

> Many effects are identified only long after exposure has occurred. Other effects are suspected to be triggered by longterm low dose exposure. There may be synergistic effects which we have yet to discover. . . . Today's picture shows a broad spectrum of substances at low concentrations which collectively give rise to unspecific effects.
>
> Chemicals Policy Committee 1997, p.14.

Introduction

The previous Chapter provided a detailed analysis of the risk assessment process that is used in regulatory toxicology. Attention was drawn to the many areas in which data is inadequate, and to the consequent use of uncertainty factors and assumptions as a means of addressing this problem. Uncertainty exists in the extrapolation of animal data to humans. Assumptions underlie this extrapolation. They also underlie the estimation of exposure to pesticides. Uncertainty factors of ten, together with various mathematical models, enable the provision of quantitative estimates of risk that are then used to characterize risk as negligible, acceptable, or tolerable, or conversely as significant and unacceptable. This desire for quantification may also effect the types of hazard that are initially selected as adverse effects for measurement in laboratory animals, for not all are addressed by regulatory toxicology. Many of the effects of chemicals are subtle and difficult to quantify (Carpenter, Arcaro, Bush, Niemi, Pang & Vakharia 1998, p.1263-4), but as Beck (1992) noted, the acknowledged dimensions of hazards tend to be limited by their "technical manageability" (p.29). This manageability does not, of course, limit the hazard, only the recognition of it.

Hence a significant number of subjective judgements must be made in the course of a regulatory risk assessment, and these logically derive from the value systems of the person and/or institution that must make those judgements. A case study was reviewed, demonstrating that the values systems involved tend to be protective of economic and industry interests rather than public health and environmental interests, despite the alleged conservatism built into the uncertainty factors.

It is contended that as a result of this values system bias, a positivist approach to rationality, and what Margolis (1996) referred to as "habits of mind" (p.3), regulatory toxicology fails to acknowledge and include several areas of risk that increasingly are becoming areas of concern. In the previous chapter brief mention was made of the newly emerging understanding of endocrine disruption and of the concern about the

special vulnerability of children. Efforts are being made by the US regulatory system to incorporate the first of these into its risk assessment process, and recent legislation has attempted to address the second, although inadequately according to Landrigan *et al.* (1999, p.435). However there are other areas in which, it is contended, risk assessment is failing. The underlying problem is the inability of risk assessment to accurately model human and environmental experience. In reality humans are exposed, usually at low levels but on an ongoing lifelong basis, to mixtures of chemicals from many different sources.[1] The risk assessment process looks at the effect of only one chemical on the average human, mainly in terms of short- to medium-term exposure, although for cancer risk assessment the exposure is assumed to be life-long. This chapter will look more closely at evidence of, and hypotheses about, the effects of chemicals on humans as they are normally experienced. First, a look will be taken at the effects of low level mixtures on laboratory animals with some supplemental human data. Secondly, the effects on humans in terms of multiple chemical sensitivity will be addressed. The section on risk at the beginning of Chapter 3 provided the usually accepted definition of risk as that of hazard x exposure. It also introduced the challenge that has been issued to toxicology by Dr Claudia Miller (1997) in asserting that there is a third factor, that of interaction with the human being. This assertion is well illustrated by the subject of multiple chemical sensitivity. However, before either of these situations is analysed, a brief contextual background on the nature of rationality within science is provided, in order to illustrate better why toxicology fails in these areas.

4.1 Rival rationalities within science

Rival rationalities is a term usually used to describe the differences between the rationalities underlying technical and lay assessment of risk, the one theoretically being characterised by the quest for objective truth (Gori 1996, p.304), and the other by a wide range of social and cultural factors. It is not unusual for writers to give the impression that science has but one rationality, that of the positivism of objective scientific observations derived from purposeful experiments (Gori 1996, p.305) such as form the basis of hazard assessment. Such a view, however, is challenged by Shrader-Frechette

[1] In fact, the issues of endocrine disruption, the vulnerability of children and the effects of mixtures of chemicals are all interwoven. To separate them, as has been done here, is to resort to reductionism in a manner that threatens to diminish the importance of the compounding effects of each of these failures in current risk assessment. They are separated here because they are used to illustrate failings of the assessment process. Their separation in the assessment process renders them technically more manageable on the one hand, but on the other serves to reduce the apparent risk of pesticides.

(1991) in her searching analysis of rationality and risk in which she noted the differing views within science of what is rational. Rival rationalities within science are especially pertinent to the assessment of risks from pesticides. The sections on habits of mind and experience with respect to multiple chemical sensitivity will demonstrate this rivalry.

The attributes of the positivism approach to rationality are well portrayed by Gio Gori,[2] who summarised some of the rules of scientific method relevant to hazard identification and risk assessment.[3] They include the following:

> —Scientific observations derive from purposeful experiments that test whether outcomes of causal hypotheses are reproducible or forecastable and may thus lead [to] validated predictive theories.
>
> —Phenomenological observations (i.e. fact gathering, survey type, or fortuitous observations) do not constitute verified knowledge unless fitting in the context of verified theories.
>
> —Science is value-neutral.
>
> —Science has no interest in propositions that cannot be tested.
>
> —Only experiments reproducible under equal conditions produce observations that can validly verify a theory.
>
> Gori 1996, p.305.

Gori (1996) concluded that science "alone produces virtual truths of physical significance" (p.306). It alone can "verify knowledge according to statistically reliable experimental predictivity". Thus, "predictive knowledge would seem a compelling determinant of rational choices in public and private affairs" (p.306). He added, "it is plainly irrational to fear risks the existence of which is conjectural" (p.306). Thus argued Gori in favour of admitting only that which is validated by scientific experiment as a determinant of the truth and hence of use to public policy. He did acknowledge that natural science cannot deal in absolutes because of "imperfections in observation and measurement" and the "apparent stochastic nature of physical reality" (p.305). These limitations, however, he regarded as being "insignificant when it comes to technological application because virtual verification is attainable on the basis of sufficient criteria of probability" (p.305). Professor David Bates's comment on the establishment of causal relationships between exposure to pollutants and adverse health effects provided,

[2] Gio Batta Gori, The Health Policy Center, Bethesda, Maryland.
[3] The subject of positivism is discussed in further detail in Chapter 6.

however, a different perspective on the positivist approach and these 'insignificant' limitations:

> I have noted that animal toxicologists, who are able to control all variables in their experiments, generally seem to be biased against making causal inferences unless the mechanisms are fully understood. They, and others, may also be influenced by the idea that, since good science is necessarily cautious, being more cautious represents better science. This kind of primitive thinking often passes as wisdom.
>
> Bates 1994, p.65.[4]

Gori's comments are very important to this thesis, for they reveal the thinking that underlies the risk assessment process of pesticides and the policy decisions that surround them, especially in New Zealand where only knowledge gained using the positivist scientific method is admissible. It is contended that it is precisely those limitations of natural science, which Gori regards as insignificant, that severely undermine the usefulness of risk assessment as a decision-making tool. It is also contended that it is the characteristics of the positivist approach to rationality and its accompanying scientific method that, at least in part, delays the acceptance of human experience with respect to the effects of pesticide exposure. It is the lack of validated predictive theory that prevents the acceptance by toxicologists, and hence the risk assessment process, of multiple chemical sensitivity. Gori's assertion of science as value-neutral has already been demonstrated, in Chapter 3, to be unsupportable at least in regulatory toxicology.

4.1.1 Habits of mind

Margolis (1996) added to the usual list of reasons for the irreconciliability of public and expert assessment the problem of habits of mind. He referred to the lay assessor as being "susceptible to misleading cues", and to the technical assessor as having "habits of mind that focus attention quickly and intently on some aspects of a situation and block off many other things that the expert has come to see as ordinarily unimportant or misleading" (p.35). Freudenburg (1996), too, noted the problem that everyone is at "risk of being prisoners of their own perspectives" (p.49), sometimes because underlying value systems result in some areas being more intently focussed upon than others. Luhmann (1993) put the same concept in another way when he referred to the effects of one's socialization in inducing behaviour expected of one's "pertinent

[4] David Bates, Professor Emeritus of Health Care and Epidemiology, and formerly Dean of Medicine, University of British Columbia.

reference group" (p.3). Freudenburg (1996) referred to the further danger of "unknown unknowns", blind spots that not only do we fail to see, but also that "we fail to see that we fail to see" (p.49).

Whilst Margolis tended to emphasize the problem with respect to the public's habits of mind, it is contended that the technical expert's long training in narrowing his or her field of vision is a greater problem. Thomas Kuhn (1962), in describing scientific revolutions that gave rise to 'paradigm shifts', referred to the preceding blindness of one side of a controversy to the argument of the other side—incommensurability. Is such a situation possible with the first principle of toxicology? Has it become a habit of mind that blinds experts to reality, or in the words of Margolis (1996) "yield[s] illusory judgements" (p.69)?

The first principle of toxicology is that the dose makes the poison. That may be true, but the problem lies in determining what dose is it that makes the poison? There are two aspects to this problem:

1. The assumption of a positive dose-response

The first aspect is the logical extension of the 'dose makes the poison' concept to the positive dose-effect curve: as the dose increases so does the poisonous effect. Hence, if a high dose of a pesticide does not cause ill effect in the laboratory rat, a lower dose cannot. But does this apparent logic in fact accurately describe what happens in reality, or is it just a Margolian habit of thinking, a Kuhnian paradigm that has not shifted since Paracelsus first espoused it in the sixteenth century? Evidence was presented in Chapter 3 to suggest that it may be the latter. Some emerging science suggests that it is possible to have non-linear (Colborn *et al.* 1996) and inverse dose-response effects (Olson *et al.* 1987; Shiraz *et al.* 1990; Porter *et al.* 1993; Lodovic *et al.* 1994). There is no scientific consensus that these scientists are correct in their hypotheses and the outcomes of their studies, but no proof that they are not either. Interestingly, this inverse response is an integral part of homoeopathic treatment, which many scientists continue to deride because its tenets are contrary to conventional dose-response wisdom, despite empirical evidence that supports its effectiveness.[5] Interestingly also, a comment by Bates (1994) that "it is not possible to conduct a formal risk assessment unless there is some capability of constructing a dose-response relationship" (p.70). It is important to note that writers on the subject of risk

[5] For evidence of effectiveness see, for example, Ferley *et al.* 1989; Jacobs *et al.* 1994; Weiser *et al.* 1998; Chapman *et al.* 1999; Datta *et al.* 1999; Rastogi *et al.* 1999; Balzarini *et al.* 2000; Jacobs *et al.* 2000; Straumsheim *et al.* 2000; Taylor *et al.* 2000.

and risk perception, writers far removed from actual toxicology also assume the dose-poison/positive dose-response relationship (e.g. Wildavsky 1988, p.24; Thompson *et al*. 1990; Margolis 1996). If that assumption is removed, using risk assessment as the basis of pesticide policy becomes highly questionable.

Whilst toxicologists have embraced with vigour and determination Paracelsus's concept, espoused more than 400 years ago and unchanged today, other aspects of Paracelsian science have been rejected. Deichmann *et al.* (1986) described his science as being "mixed with an overdose of mysticism, astrology and neo-Platonism" (p.207), values that must be anathema to toxicologists today. Paracelsus's theory on dose was derived from a period in which science and medicine were fairly rudimentary, and medical treatments coarse. Paracelsus also espoused the principle that it is the disease that should be treated not the diseased person or their state. This concept has formed the bedrock of allopathic medicine, but yet gradually there is an increasing understanding of the interplay of the mind and the physical state, of the physical state and the specific disease manifested. Increasingly, modern medical practitioners are struggling to treat the whole person, although often with inadequate tools for the job. Multiple chemical sensitivity highlights this problem. Yet, whilst both science and medicine have undergone enormous advances and refinement of thinking, that refinement of thinking has not extended, apparently, to toxicology and in particular to the positive dose-response/dose-poison concept:

> One of the things a scientific community acquires with a paradigm is a criterion for choosing problems that, while the paradigm is taken for granted, can be assumed to have solutions. . . . A paradigm can, for that matter, even insulate the community from those socially important problems that are not reducible to the puzzle form, because they cannot be stated in terms of the conceptual and instrumental tools the paradigm supplies.
>
> Kuhn 1962, p.37.

> Because it demands large-scale paradigm destruction and major shifts in the problems and techniques of normal science, the emergence of new theories is generally preceded by a period of pronounced professional insecurity. As one might expect, that insecurity is generated by the persistent failure of the puzzles of normal science to come out as they should. Failure of existing rules is the prelude to a search for new ones.
>
> Kuhn 1962, p.67-8.

It is contended that this is the situation with multiple chemical sensitivity and its challenge to the dose-response belief. It is not suggested that the concept of a positive-

dose response relationship is wholly wrong. It obviously is very often correct. The problem lies in the slavish adherence to the concept, that it must always be right. It fails to allow for those situations, those aspects of the human complexity in which it is not correct, such as were demonstrated in Chapter 3 and will be highlighted further in this chapter.

2. The individual person

The second aspect of the problem is defining what dose it is that constitutes a poison for a particular person. Even supposing the dose-response does follow a positive linear curve, at what dose does the response begin, and at what dose is this response in some way significant for the individual person rather than the statistically average person? It is this aspect of the problem that will be highlighted by the section on multiple chemical sensitivity with respect to individual sensitivity to pesticides. However, it is also the aspect of the dose-response problem that underlies the issue of exposure to a number of different chemicals at the same time, such as is normal human experience.

4.2 Low dose exposure to multiple chemicals

> Little is known about the impact of chemical mixtures on human health.
>
> Fisher 1998, p.A487.

The most commonly cited problem with risk assessment is the lack of knowledge of the effects caused by exposure to a mixture of chemicals. Reference to this problem can be found in writings emanating from public interest organisations (e.g. Montague 1999), risk assessors (e.g. Fan *et al.* 1995), toxicologists (e.g. Lucier & Schecter 1998), biologists (e.g. Porter *et al*. 1993) and public health experts (e.g. Carpenter *et al.* 1998).

The complex reality of human existence is that people are exposed to mixtures of chemicals, including pesticides, fertilizers, food additives, exhaust fumes, dioxins, industrial chemical and hazardous waste emissions, drugs, tobacco smoke, alcohol, paints, solvents, and cosmetics. Exposure can be simultaneous or sequential, both types causing potential health concerns (Feron, Cassee & Groten 1998, p.1281). According to Lucier and Schecter (1998, p.623), there are approximately 70,000 chemicals currently in use.[6] Theoretically, any of these can interact with any or all of the others in several different ways: they may have additive, synergistic, potentiative, or antagonistic effects,

[6] Even this number is not known with certainty: Brandy Fisher (1998) reported that the number was more than 80,000. Hansen *et al.* (1998) also used the figure of 70, 000, with approximately 7 million chemicals in existence.

or no interaction at all. Additive effects occur when two or more chemicals act at the same site in the body, altering the same process by different mechanisms (Carpenter *et al*. 1998, p.1264). Synergism involves the interaction of two or more chemicals in such a way that the toxic effect of the combination is greater than the sum of the individual toxic effects (Arnold *et al.* 1996). Potentiation is a process in which two chemicals together exert effects that are entirely different from those of either chemical alone (Timbrell 1991, p.9,10). An antagonistic effect occurs when one chemical interacts with another to reduce the overall toxic effect. All these processes confound regulatory risk assessment, which is based on a single chemical alone, but it is synergism that is of the greatest concern.

The simple reality of a typical laboratory study is that it assesses "the controlled exposure of experimental animals to a single chemical by a single route for a specified period of time" (Hansen *et al.* 1998, p.1271). Human exposure usually involves a combination of exposure pathways, timing patterns and doses, according to Hansen *et al*. (1998, p.1273), as well as a combination of chemicals.[7] Regulatory risk assessment is incapable of assessing the actual effect of a single pesticide in combination with other pesticides, let alone the other 70,000 chemicals in use, and the few that are no longer in use but remain as environmental contaminants, such as dioxin and PCBs. There are also the additional chemicals that are not intentionally released but are breakdown products of those that are, such as pp DDE. The possible number of interactions between all these chemicals is near infinite, and it is beyond current science to experimentally test these, and beyond regulatory toxicology to assess the actual risk (Fan *et al*. 1995, p.346). Groten, Schoen, van Bladeren, Kuper, van Zorge and Feron (1997, p.15) reported that the number of possible chemical combinations in a sample of groundwater contaminated with only twenty-five chemicals is 33,554,431.[8] Another analysis showed that 166 million different experiments would be required to test the 1,000 most common toxic chemicals in unique combinations of three at a single dose per experiment (Krimsky 2000, p.212).

Additional complications arise from the fact that a single compound may act on multiple sites in the human body, mediated by totally different mechanisms. Metabolites may or may not have biological activity similar to the parent compound, in effect resulting in a single compound becoming a functional mixture. Yet another complication occurs with age, for a single chemical may cause different effects at different ages (Carpenter *et al*.

[7] Agency for Toxic Substances and Disease Registry, Division of Toxicology, Atlanta.
[8] They cited Yang & Rauckman 1987.

1998, p.1264). Of particular concern are the effects of mixtures on the developing foetus which is "exquisitely sensitive" to chemicals at certain critical time periods, during which exposure may result in transgenerational effects (Hansen *et al*. 1998, p.1271). The effect of exposure to a synergistic combination of chemicals, or even an additive combination at these critical periods remains unknown.

Toxicity Equivalent Factors have been developed for some common chemical mixtures, based on structure-activity relationships and some *in vitro* screening. However, it is important to note that for this purpose, according to Fan *et al*. (1995, p.346), the usual *assumption* is that the chemicals have additive rather than synergistic toxicities. Thus, synergistic effects are assumed not to occur. Feron *et al*. (1998) provided details of a number of other testing and modelling procedures that are available or under development.[9] Using these methods, the potential effects of some chemical mixtures are under scrutiny, but these tend to be mixtures like emissions from hazardous waste sites or diesel exhaust (Feron *et al*. 1998). To date, there appears to have been no study on, for example, the combined effects of the seventeen pesticides that were found in cucumber in a 1990/91 New Zealand food survey (MAF & DoH 1992). Neither has there been testing of the effects of these pesticides combined with the 100 or more volatile organic compounds that have been found in US indoor air samples (Feron *et al.* 1998, p.1284) and might therefore be inhaled while the cucumber is being eaten (leaving aside the obvious geographical difficulties). There have been some laboratory studies carried out on a very limited number of pesticides in combination, and several of these will be reviewed below, for they provide interesting results. Meanwhile, some idea of how important food residues may be in terms of low dose exposure to multiple chemicals, may be gained from a report by the Environmental Working Group (Wiles, Cook, Hettenbach & Campbell 1999). Their research revealed the following information about children's exposure to pesticide residues:

- More than one quarter of a million US children aged one to five eat twenty different pesticides every day.
- Over twenty million children under the age of five eat an average of eight pesticides a day, every day, totalling 2,900 pesticide exposures per child per year from food alone.

[9] Victor Feron, John Groten, TNO-Nutrition and Food Research Institute, Toxicology Division, Zeist; Flemming Cassee, National Institute of Public Health and the Environment, Bilthoven, The Netherlands.

- Each day 610,000 children aged one to five eat doses of organophosphate insecticides that exceed the US EPA's 'safe' daily dose.[10]

- Of these, 61,000 exceed the safe dose by a factor of ten or more.

The enormity of the problem presented by chemical mixtures has meant that the regulatory response in New Zealand appears to have been to ignore it, or at least to take a positivist approach: if there is no proof of its existence, there is no problem. This is particularly so with respect to synergism.[11] However, in recent years there has been increasing debate on the subject internationally. This debate has been fuelled by the findings, by Arnold *et al.* (1996), of synergistic interactions between the pesticides dieldrin, endosulfan and toxaphene in their effect on human oestrogen receptors in a yeast oestrogen system, and by the authors' subsequent withdrawal of the findings because of failure to reproduce the results (McLachlan 1997). The possibility of a threat to human health arising from synergistic interactions amongst 'hazardous air pollutants', which include pesticides, was raised again by Woodruff, Axelrad, Caldwell, Morello-Frosch and Rosenbaum (1998).[12] Their estimations of outdoor air concentrations of 148 such pollutants lead them to conclude that these pollutants may pose a potential public health problem, even without synergism, with up to thirty-two of them exceeding benchmark concentrations that represent thresholds of concern for adverse public health impacts. If synergism occurs the threat is obviously much greater. Since then Bergeron, Willingham, Osborn, Rhen and Crews (1999) have proposed the possibility of synergism between low doses of weak environmental oestrogenic chemicals and natural estrogens, based on their work with red-eared slider turtles.[13]

[10] More than 320,000 of these exposures result from only one pesticide, methyl parathion (Wiles *et al.* 1999, p.2). Since this report, the US has moved to dramatically reduce the level of residues of methyl parathion in food. As reported in Chapter 3, the New Zealand government responded to suggestions that they should do the same with no action, because of a lack of scientific proof that there is a problem (Reeve 1999).

[11] When New Zealand's Pesticide Board was requested to take action regarding hormone-disrupting pesticides (White 1997), toxicologist John Reeve dismissed the possibility of synergism by referring only to a paper by Arnold *et al.* (1996) that was subsequently withdrawn. Reeve concluded that adverse effects of pesticides on human health via endocrine disruption have not been established. Additionally, the morning after pill, birth control pill and hormone replacement therapy give rise to substantially greater exposure to oestrogenic activity than do pesticides. Therefore, he concluded, "this information would strongly indicate that it is unlikely that pesticides need any special controls at this time" (Reeve 1997, p.4).

[12] U.S. Environmental Protection Agency; School of Public Health, University of California, Berkeley; ICF Kaiser, Systems Applications Division, San Rafael, California.

[13] Department of Zoology, University of Texas at Austen.

4.2.1 Laboratory studies of low dose mixtures

A number of laboratory studies have approached the subject of the effects of low dose mixtures of pesticides through a comparison with the effects of individual pesticides. A small sample is briefly reviewed here as an indication of interest in the subject.

One study worthy of mention is that of Lodovici *et al*. (1994), briefly referred to in Chapter 3, and again earlier in this chapter with regard to its findings of an inverse-dose response effect of pesticides on the DNA of two enzymes in rat liver. However, it is revisited again, for the finding related not to a single pesticide, but rather to a mixture of fifteen commonly used pesticides. The conclusion drawn from this study was that "relatively low levels of common pesticides, administered daily were able to induce a significant increase in the levels of 8-OH-2-deoxyguanosine in DNA, an indicator of oxidative damage mediated by free radicals" (p.166). The important aspect is that the doses tested were comparable to human chronic exposure, according to the authors (p.166).

A study of the effects of triazine herbicides at concentrations found in Illinois drinking water supplies, found that atrazine and simazine caused chromosomal damage but that a third herbicide, cyanazine, did not (Taets, Aref & Rayburn 1998). No synergistic effects were found in this study, but another one involving atrazine did find synergistic effects at low dose levels. This was a five year study on rats, which found that mixtures of atrazine, the insecticide aldicarb, and nitrate fertilizer caused endocrine, immune and behavioural changes, but rarely did any of the chemicals on their own cause these effects (Porter, Jaeger & Carlson 1999). Significantly, also, the dose levels used were those of the maximum permissible contaminant levels in groundwater in the USA. Since these groundwater maximum levels are regularly reached for a number of chemicals (Porter *et al.* 1999, p.133), it is reasonable to assume that the doses used reflected ambient levels. The finding of no significant biological effect by individual chemicals at groundwater concentrations agreed with standard toxicology assessments, further emphasizing the deficiency of regulatory assessment with respect to mixtures. The authors noted the occurrence of significant effects with the presence of nitrate in any of the combinations of chemicals tested, and that pesticide-fertilizer mixtures "are ubiquitous in aquatic environments, soils and the atmosphere" (Porter *et al.* 1999, p.142).

Much of the concern regarding low level effects of mixtures of pesticides relates not to the more commonly characterised carcinogenic effects, but rather to effects on neurological, endocrine, immune or developmental functions, which are especially

sensitive, according to Porter *et al*. (1993, p.16). Fan *et al*. (1995, p.349-50) paid attention to the fact that pesticides are known to modulate immune system function at low doses. They acknowledged the current uncertainties in scientific knowledge in this area, including the relationship of these changes to actual health effects. Studies reported by Olsen *et al*. (1987) and Shiraz *et al.* (1990) revealed suppression of the immune system by the nematicide aldicarb, at doses as low as 1 part per billion (ppb). Porter *et al*. (1993) found interactive effects between three pesticides (aldicarb, methomyl and metribuzin) on thyroxine levels in rats. They noted that "the same concentrations and mixtures of these three pesticides have now been shown to be implicated in learning impairment and other neurological functions, immune parameter changes, and endocrine changes, and concluded that the results "strongly suggest the need to reassess currently allowed 'safe' levels of chemicals" (p.15).

In their subsequent five-year study, Porter *et al*. (1999) found that "thyroid hormone concentration change was consistently a response due to mixtures, but not usually to individual chemicals" (p.136). Earlier studies had also indicated that "neurological, endocrine, immune and developmental effects may show up only when pesticides are tested in combination" (p.135).[14] The importance of this work cannot be underestimated, for it begins to draw together the findings of laboratory studies on animals and some of the effects of pesticides on people as described in the condition of multiple chemical sensitivity. It also has implications for the attempts to find satisfactory tests for endocrine disruption that can be used in regulatory toxicology. Disruption of the thyroid hormone is one of the significant effects of endocrine disruptors. As well as controlling the body's rate of metabolism, the thyroid is essential to organ development and normal function. Interference with thyroid function can result in a variety of effects including reduced growth, minimal brain dysfunction syndrome, and abnormal testicular development (Carpenter *et al*. 1998, p.1265-6). However, if the effect is seen at normal exposure levels only with chemicals in combination, as suggested by Porter *et al*. (1999), then traditional single chemical testing will not suffice for an accurate identification of pesticides that pose this hazard.

4.2.2 Epidemiological evidence and case studies

Further light may be shed on the potential effects of low dose chemical mixtures by the use of epidemiological and case studies. A substantial number of such investigations into the relationship between exposure to pesticides and human health have been carried out. Some studies attempted to provide evidence of a linkage between a

[14] Boyd, Weiler & Porter 1990; Porter *et al*. 1993.

particular pesticide, or pesticides, and specific diseases (e.g. Kettles, Browning, Prince & Horstman 1996).[15] Such causal linkages are notoriously difficult to establish for a number of reasons. The ubiquitous nature of pesticides creates difficulties in providing a control group not exposed to the one(s) under study. A similar problem occurs with eliminating other possible chemical causes of the observed health effect. Additionally, each population under study incorporates many biological and social factors that may influence the association, including genetic variability, socio-economic status, traditional customs and/or acculturation, dietary and smoking patterns. All of these factors can influence the results, and "are frequently used to question, criticize and even discount research findings involving the impact of pesticides", according to Guillette, Meze, Aquilar, Soto and Garcia (1998, p.347).[16] So too are questions of sample size and statistical validity. Public policy is left with an indication that a particular chemical, or class of chemicals, may be causative of a certain health effect, but it can't be proven, and the study will have been criticised or condemned by at least some interests.

This policy dilemma is well illustrated by two recent case control studies that found a significant increase in non-Hodgkin lymphoma linked with exposure to the herbicide glyphosate (Nordstrom, Hardell, Magnusson, Hagberg & Rask-Anderson 1998; Hardell & Eriksson 1999). The reported response from Monsanto, manufacturers of the herbicide, was that the results were not scientifically valid for reasons that include a lack of statistical significance and the fact that previous studies had not found a relationship with cancer (Puvaneswary 1999). The authors of the studies warned that definite conclusions could not be drawn, but that glyphosate deserves further study. Where does that leave public policy? The choices are that of waiting for further studies and risking additional exposure of the public to a chemical that may be causing cancer, or taking action to limit exposure to a potential carcinogen even though it may not in fact be one. The scientific positivism approach to public policy, advocated by Gori (1996), is that of waiting until the link is proven before action is taken.[17] On the other hand, a health protective approach might be to find ways of controlling weeds other than by using Roundup. Such an approach is reported to have been taken by a local authority in

[15] The authors, from the Department of Preventative Medicine and Environmental Health, University of Kentucky, found a modest association between exposure to triazine herbicides and increased incidence of female breast cancer in Kentucky.

[16] Elizabeth Guillette Bureau of Applied Research in Anthropology, University of Arizona, Tucson; Maria Mercedes Meza, Maria Guadalupe Aquilar, Alma Delia Soto, and Idalia Enedina Garcia, all of Direccion de Investigacion y Estudias de Postgrado, Instituto Tecnologico de Sonora, Obregon, Sonora.

[17] The issue of basing policy decisions on the positivism approach to science will be further discussed in Chapter 6, with reference to endocrine disrupting pesticides.

Sweden, which, on finding residues of glyphosate in its water supply subsequent to the release of the studies, banned glyphosate from the town (McGhie 1999).

Many of the epidemiological studies are occupationally based and therefore do not necessarily reflect the actual exposure conditions of the general population (e.g. Garry, Schreinemachers, Harkins & Griffith 1996). This is not to suggest that the health of workers and they families does not matter, but rather to draw attention to the importance of the 'healthy worker effect', examined in the previous chapter. The finding, in Costa Rican farmers, of an over-representation of favourable alleles for genes that express chemical-metabolizing enzymes (Au *et al*. 1999), indicates that epidemiological studies of occupationally exposed workers might need to be adjusted to reflect the genetic expression of the general public. Au *et al.* found that those farmers with the unfavourable alleles suffered significantly more biological effects than those with favourable alleles, or those in the control population with the same 'unfavourable alleles'. Hence, it is contended, in an epidemiological study that finds no significant increase in biological effect, or an equivocal increase, a real effect may be masked by genetic selection that does not reflect the genetic status of the general population.

Of more interest here than the epidemiological links between particular pesticides and a disease, are broader comparisons of subpopulations exposed, or not exposed, to mixtures of pesticides. Guillette *et al.* (1998) carried out such a study among the Yaqui people of Mexico. They compared two groups of children sharing genetic, cultural and social backgrounds, one exposed to heavy pesticide use, and the other from an area where pesticide use was avoided. When chemical pesticides and fertilizers were embraced by many of the residents in the Yaqui valley in the late 1940s, other residents moved into the foothills in protest at the change, and stayed there. In the valley, up to 90 separate applications of pesticides were made per year, including "multiple organochlorine and organophosphate mixtures and pyrethroids" (p.349). As well as this agricultural use, household insecticides were used each day throughout the year. In contrast, the ranching lifestyle of the highlands required no pesticide use, and the government DDT applications each spring for malaria control were their only contact with pesticides. The survey revealed no differences in physical growth or other outward manifestations, but it did reveal significant differences in functional abilities. In the following areas, the valley children showed a marked decrease in function relative to the highland children: [18]

[18] The researchers also surveyed the women. They found that there was no statistical difference between the valley and highland women for problems such as spontaneous abortion, prematurity, neonatal death

- physical stamina;
- ability to catch a ball;
- fine eye-hand coordination;
- ability to draw a person, the valley children providing only random undifferentiated lines in comparison with the highland children's easily recognisable human figures;
- recall after 30 minutes, although immediate recall was equivalent;
- group play: the valley children were less creative, roaming aimlessly or swimming in the irrigation canals with minimal group interaction.

Additionally, the valley children were observed to be more aggressive, hitting siblings and becoming more upset by minor corrective comment by a parent.

The researchers concluded that the differences they found in mental/neurological functioning were indicative of brain dysfunction and held implications for learning ability and social behaviour. Some criticism has been directed at this work, according to Charles Schmidt (1999), because of the lack of a full neurodevelopmental test battery and tissue analysis for pesticide levels. However, Schmidt also acknowledged that the "findings have received considerable attention within the scientific community, and many applaud [the] work" (p.A307). This study provides possibly the only human data currently available on the neurodevelopmental effects of exposure to a mixture of pesticides (Schmidt 1999, p.A306). Whether the effects were the result of one chemical, or one class of chemicals, or a whole mixture of chemicals that may have been working additively, synergistically or independently, remains unknown. The findings, however, imply grave consequences for the future of the individual, the family, and society as a whole. They point to the necessity of considering the boarder picture of pesticide exposure, rather than being limited by the toxicology of an individual chemical under laboratory conditions.

In summary, some recent laboratory and epidemiological results have pointed to potentially profound effects of ongoing exposure to low-dose mixtures of chemicals, effects that current regulatory toxicological assessment completely overlooks. It is impossible for toxicology to ever catch up with this problem, with each year an estimated 1,000 chemicals being added to the existing collection of more than 70,000 (Hansen *et al*. 1998, p.1271). Even if computer models are developed to estimate likely effects of each and very possible combination of chemicals, it is extremely unlikely they would accurately reflect reality—given the amount of uncertainty involved in the

and birth defects. However, when the problems were viewed as a composite, the valley women had an elevated rate of pregnancy problems.

assessment of even a single chemical, and the consequent compounding of this uncertainty across a number of chemicals. The concept of testing all the possible interactions is unthinkable in human resource terms, let alone financial terms. Yet that is the general thrust of current proposals. More money is sought, or pledged, for more research on more chemical mixtures, including the collecting of more data from *in vitro* studies, the development of physiologically-based pharmacokinetic modelling, and the computational techniques of structure-activity relationships (e.g. Fisher 1998; Hansen *et al*. 1998; Lucier & Schecter 1998). Little attention is being paid to the overall concept of whether or not regulatory risk assessment is the appropriate means of policy decision-making in this context, except by public interest groups (e.g. Montague 1999). Proponents of scientific positivism, such as Gori and Reeve, assert that since these effects are not proven they should be omitted from pesticide policy decision-making processes. Yet others caution that:

> The possibility of adverse developmental outcomes in connection with low-dose exposure to chemical mixtures is real.
>
> Hansen *et al.* 1998, p.1274.

4.3 Multiple chemical sensitivity

Low dose exposure and multiple chemical sensitivity (MCS) have generally been treated as distinct issues, by distinctly different people. The former has been approached through toxicology and laboratory trials, and the latter through medical experience and hypothesis. Yet they have a common thread, and that is the effects of exposure to low doses of pesticides. Whilst low dose exposure is receiving increasing attention from toxicology, investigation of MCS remains largely in the realm of medicine and the subject remains controversial. Both issues are of prime importance to pesticide policy, for they are concerned with exposure to pesticides at every day levels. Despite the controversial aspects of MCS, or perhaps because of them, pesticide policy cannot ignore the subject. For this reason, a review of the subject is provided here, not with the intention of resolving disputes, but rather to provide an understanding of the relevancy to policy development.

Multiple chemical sensitivity is a subject generally ignored in toxicological and medical texts, and not addressed at all by regulatory toxicology. Dr Ronald Gots made mention of the syndrome in 1993, in his book on toxicology and public policy, in order to dismiss it from serious consideration:

> Attempts have been made to study systematically some of today's 'victims' of multiple chemical sensitivities. None of the systematic studies have found either consistent objective physical similarities among those diagnosed or identifiable external causes, but each has identified similar psychological characteristics and makeup among patients. The best current data suggest that certain psychological disorders and qualities predispose individuals to develop symptoms and to seek out these environmental physicians to explain these symptoms.
>
> Gots 1993, p.23.

Gots' view on multiple chemical sensitivity is lavishly packaged in value judgements aimed, it appears, at discrediting those doctors who support the thesis of MCS. The section in which he briefly paid attention to the subject was titled "Modern antiscientific sentiment and anecdotal illness" (p.21), and it contained statements such as this:

> By blaming the environment, and particularly man-made chemicals, clinical ecologists couple popular antitechnological sentiments with an explanation for otherwise unexplained physical and emotional dysfunction.
>
> Gots 1993, p.22.

He also coupled MCS with "the evil humours" of the Middle Ages and mourned the empowerment of the public, the latter meaning that physicians are no longer "treated as omniscient sages" (p.23). Gots provided no scientific evidence to dispel the 'myth' of MCS, but instead refers to five papers dated from 1968 to 1990 as the best current data. His attitude is illustrative of one approach to the subject.

However, in recent years, the upsurge of interest in multiple chemical sensitivity, as it has gained media, legal and political attention, has resulted in a plethora of scientific and medical writings on the subject, mostly from the United States. The Gots-style writings have tended to give way to serious medical research and investigation. The original identification of multiple chemical sensitivity is generally attributed to Chicago physician Dr Theron Randolph (1962) in the 1940-60s (Shorter 1997, p.37-8; IWMCS 1998, p.11). Drs Nicholas Ashford and Claudia Miller's book *Chemical Exposures: Low Levels and High Stakes*, published in 1991, appears to be the seminal text on the subject.[19] This was followed closely, in 1992, by Dr William Rea's four-volume treatise *Chemical Sensitivity*.[20] The 1990s spawned workshops such as that conducted by the US EPA in

[19] Ashford, Associate Professor of Technology and Policy, Massachusetts Institute of Technology; Miller, Clinical Assistant Professor in Allergy and Immunology, University of Texas, San Antonio.
[20] Rea, Environmental Health Centre, Dallas, Texas, USA.

1992 (NRC 1992) and the Workshop on Experimental Approaches to Chemical Sensitivity in New Jersey in 1995 (Fiedler & Kipen 1997a), symposia such as that held in Baltimore, Maryland in 1995 (Anonymous 1996), a new edition of Ashford and Miller's book in 1998, and a multitude of journal articles—*Medline* identified 125 such articles in peer reviewed journals between January 1996 and September 1998.[21] An entire issue of *Environmental Health Perspectives*, the journal of the USA's National Institute of Environmental Health Sciences, was devoted to the subject in 1997 (Fiedler & Kipen 1997a). The US government's Interagency Workgroup on Multiple Chemical Sensitivity (IWMCS) produced a 'predecisional draft' report on the subject in August 1998.

Yet, far from settling the controversy that has always dogged the subject, the modern writings have continued to fuel it. There are essentially two opposing points of view: on the one hand that multiple chemical sensitivity exists as a physical condition, and on the other hand that it is all in the mind, i.e. 'merely' a psychological problem that has nothing to do with the toxicity of chemicals. In part this difference arises from the results of case studies,[22] and in part from differences in philosophical approach to a lack of evidence as typified by the following statements:

> One must be very careful in these days of chemical misperceptions not to over catalogue perceived chemical effects. . . . Without clear and reproducible chemical characteristics, it is dangerous and scientifically erroneous to hypothesis a mechanism derived from 'individual susceptibility' to explain perceived adverse consequences of chemical exposures.
>
> Gots 1993, p.54.

> Sufficient 'proof' is not available to satisfy the most sceptical critic that chemical sensitivity exists as a physical entity, nor is there convincing evidence that it does not.
>
> Ashford & Miller 1991, p.xi.

In part, too, the controversy is fuelled by a lack of agreed case-definition of exactly what constitutes MCS, particularly in terms of laboratory tests and clinical manifestations (IWMCS 1998, p.7). Studies on the syndrome are subjected to intense criticism on the basis of differing views of what constitutes MCS, and on the failure to demonstrate precise biological markers. As a consequence of the lack of agreed definition, estimates of its prevalence vary widely and are similarly disputed. Even the name of the

[21] INTERNET database of more than 3,300 medical journals.

[22] Such as Black, Rathe & Goldstein 1990; Simon, Daniell, Stockbridge, Claypoole & Rosenstock 1993; Miller & Mitzel 1995; Bell, Peterson & Schwartz 1995; Bell, Miller, Schwartz, Peterson & Amend 1996; Davidoff & Keyl 1996.

syndrome is open to dispute. It has been variously referred to by a number of titles, including environmental illness, ecological illness, total allergy syndrome, and the 20th Century disease. However, multiple chemical sensitivity is the current, generally applied term (IWMCS 1998, p.13). In 1999 thirty-four researchers and clinicians, "with experience in the study, evaluation, diagnosis, and/or care of adults and children with chemical sensitivity disorders", signed a consensus statement on the criteria that should be used to define MCS (Bartha *et al.* 1999, p.147).[23] These criteria are as follows:

- The symptoms are reproducible with repeated chemical exposure.
- The condition is chronic.
- Low levels of exposure, lower than previously or commonly tolerated, result in manifestations of the syndrome.
- The symptoms improve or resolve when the incitants are removed.
- Responses occur to multiple chemically unrelated substances.
- Symptoms involve multiple organ systems.

However, it is important to note that there are some glaring absences from the signatures to the document, with no explanation provided. These include Drs Ashford and Miller, authors of two books on the subject and the latter author of numerous papers, Dr Rea, and Dr Iris Bell.[24] Dr Bell and her colleagues have provided a substantial contribution to the models of casual mechanisms for MCS, and their theory of sensitization of the brain's limbic system is regarded by UK reviewers Graveling, Pilkington, George, Butler and Tannahill (1998), as being the most strongly supported hypothesis.[25] Without an explanation for such notable absences, an open mind must be kept at this point regarding these criteria.

The remainder of this chapter will briefly review some of the recent literature in support of each side of the argument, including causes, symptomatology, mechanisms of multiple chemical sensitivity, conflicting scientific opinion, and will conclude with a look at implications for pesticide policy.

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[23] The thirty-four are: Liliane Bartha, William Baumzweiger, David Buscher, Thomas Callender, Kristina Dahl, Ann Davidoff, Albert Donnay, Stephen Edelson, Barry Elson, Erica Elliott, Donna Flayhan, Gunnar Heuser, Penelope Keyl, Kaye Kilburn, Pamela Gibson, Leonard Jason, Jozef Krop, Roger Mazlen, Ruth McGill, James McTamney, William Meggs, William Morton, Meryl Nass, Christine Oliver, Dilkhush Panjwani, Lawrence Plumlee, Doris Rapp, Myra Shayevitz, Janette Sherman, Raymond Singer, Anne Solomon, Aristo Vodjani, Joyce Woods, and Grace Ziem.

[24] Dr Iris Bell, Departments of Psychiatry and Psychology, University of Arizona, and Department of Psychiatry, Tucson Veterans Affairs Medical Centre, Tucson, Arizona.

[25] Institute of Occupational Medicine, Edinburgh.

4.3.1 Cause

A common description of MCS is that sensitivity to chemicals involves a two-stage process: loss of tolerance to chemicals following exposure to various toxicants, followed by triggering of symptoms by extremely small amounts of previously tolerated chemicals, drugs and foods (Rea 1992; Miller 1997, p.445; Bell, Schwartz, Baldwin, Hardin, Klimas, Kline, Patarca & Song 1997a, p.457). Rea (1992, p.9-10) described a number of ways in which such sensitivity might arise, and identified the likelihood of each scenario based on 200,000 cases treated at the Environmental Health Centre-Dallas:

- From a single exposure to a large dose of a toxic substance (13 percent), known examples including exposure to mustard gas during World War I, to Agent Orange in Vietnam, and to massive doses of isocyanate following the Bhopal factory explosion.
- Subsequent to a severe bacterial, viral or parasitic infection (1 percent).
- From exposure to ambient doses of toxins after massive trauma (12 percent), childbirth (9 percent), surgery (2 percent), or other causes including immunizations (1 percent).
- From accumulative subacute toxic exposures over time (60 percent).
- Unknown causes (2 percent).

Frequently, it has been assumed that the causes of onset of MCS are occupational exposure to hazardous chemicals, occupation of 'sick buildings', or living in contaminated communities. This analysis was put forward by Ashford and Miller in 1991 and subsequently has been cited by a number of writers (e.g. Davidoff & Keyl 1996; Brod 1996). More recently, Gulf War veterans have been added to this list of susceptible groups (Bell, Peterson & Schwartz 1995, p.151; Miller & Mitzel 1995; Bartha *et al*. 1999) because of symptoms that have arisen as a result, it is hypothesized, of their exposure to a mixture of chemicals and other environmental risks (Fiedler, Kipen, Natelson & Ottenweller 1996, p.S130).

Increasingly, exposure to organophosphate insecticides is being suggested as an important cause of MCS (Miller & Mitzel 1995; Davidoff & Keyl 1996; Meggs, Dunn, Bloch, Goodman & Davidoff 1996; MacPhail 1997, p.455). In 1998 Ashford and Miller (p.235-6) noted the similarity between the symptoms of MCS and those exposed chronically to organophosphates, such as UK farmers who have used organophosphate

sheep dips (Ahmed & Davies 1997). Ashford and Miller (1998) referred to a 1966 study in which it was found that "some" (p.236) of a group of 114 agricultural workers with acute organophosphate poisoning subsequently developed chronic MCS-type symptoms.[26] Other writers have pointed to the involvement of pesticides in general (e.g. Rea 1992; Bell *et al.* 1997a, p.457). Ashford and Miller (1991, p.5) reported a survey of 6,800 people who claimed to be chemically sensitive: of these 48 percent claimed that the initiating factor was pesticides (20 percent did not know the cause). In 1994 Dr Grace Ziem reported that chemicals that tend to induce or exacerbate symptoms "have typically been pesticides, other petrochemicals, coal-derived chemicals, and combustion products" (p.240). However, in 1997, Grace Ziem and James McTamney (p.426-7) pointed specifically to the involvement of the organophosphates chlorpyrifos and diazinon, and to chlordane, malathion, pendamethalin, or cypermethrin in some patients.[27] Finn Levy (1997, p.70) mentioned insecticides used indoors—chlorpyrifos is the one of the most commonly used indoor insecticides in the USA (Landrigan *et al.* 1999, p.432).[28] In a study of people exposed to organophosphate or carbamate insecticides, Claudia Miller and Howard Mitzel (1995, p.121) found that those most commonly implicated in MCS were chlorpyrifos, diazinon, malathion and carbaryl.[29] Perhaps it is the possible involvement of the indoor organophosphates that explains the difference between Miller and Ashford's proposed most susceptible people and those found by Cullen and Redlich (1995, p.1812-3) to actually be more susceptible, as will be discussed in the next section.

There is no precise information on exactly what levels of exposure to chemicals will cause chemical sensitivity in the first place, or trigger symptoms in the second place. Miller (1997) referred to several studies that report disabling illness "at levels not generally regarded as toxic" (p.445).[30] Ziem (1994) noted that "the pesticide residues legally allowed in food can be too high for chemically sensitive patients" (p.244). Rea (1992, p.866), also, made the point that the legal maximum safe levels of residues in foods can trigger chemical sensitivity. Bell *et al.* (1997a) referred to "non toxic levels" (p.457) of chemicals as capable of triggering reactions in the already chemically sensitized person.

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[26] Tabershaw & Cooper 1966.
[27] Ziem, Occupational and Environmental Medicine, Baltimore, Maryland; McTamney, Clinical Psychologist, Lutherville, Maryland.
[28] Levy, Department of Environmental and Occupational Medicine, Centre for Preventative Medicine, Ulleval University Hospital, Norway.
[29] Miller and Mitzel, Department of Family Practice, Environmental and Occupational Medicine, The University of Texas Health Science Centre at San Antonio.
[30] Cullen 1987; Cone & Sult 1992; Rosenthal & Cameron 1991; Ziem 1992.

Whilst this thesis is concerned with pesticides, and therefore the emphasis is paced on the role of pesticides in multiple chemical sensitivity, it should not be assumed from this that these are the only chemicals involved in the syndrome. They may or may not be the precipitating factor in its onset. However, once it has developed, the person may become sensitive to a wide range of chemicals including cosmetics and perfumes, aerosol air fresheners, laundry and dishwashing detergents, petrol fumes, cleaners and cigarette smoke (IWMCS 1998, p.12).

4.3.2 Effect

The effects of multiple chemical sensitivity are commonly non-specific symptoms, usually involving multiple organ systems, which recur with exposure to chemicals and then usually clear away when exposure is avoided (refer Table 4.1). Although the symptoms are reported to vary from person to person, Ann Davidoff and Penelope Keyl (1996, p.210) found, in their survey, that the organ systems involved are quite consistent between MCS suffers: typically upper and lower respiratory, gastrointestinal, musculoskeletal, central nervous and dermatological systems.[31] The condition is chronic (Bell *et al.* 1997a, p.457; Bartha *et al.* 1999). The effects can not usually be verified by normal medical tests. One common method of confirmation in USA is by the use of the clinical ecology techniques of unmasking and provocation. This involves removing the person from all possible chemical stimuli for a period to allow the body to de-adapt, and then 'challenging' that person with a measured exposure to the chemical or chemicals (California Medical Association 1986; DeHart 1992, p.36; Levy 1997; Miller 1997). This method is not regarded as acceptable verification of physical effect by the orthodox scientific establishment (DeHart 1992, p.36; Sikorski & Rodgers 1995; Levy 1997, p.771; Shorter 1997). Even less acceptable to the latter are the methods used clinically in New Zealand—usually either Electro-acupuncture by the Method of Voll (EAV), or Applied Kinesiology (Watts 1994, p.61,65,73). Standard immunology tests have not provided results acceptable to the scientific orthodoxy either. Typically, the results may show abnormalities, but there is a lack of consistency in the direction of those abnormalities (e.g. Rea 1992, p.193-203; Meggs 1992, p.162-4; Brod 1996, p.204-5; Rowat 1998). This may, in part, be because of the dramatically different patient groups being studied by different researchers, according to Meggs (1992, p.163), and to the different criteria that were used for determining the existence of MCS.

[31] Davidoff, Department of Environmental Health Sciences, and Keyl, Department of Epidemiology—both of the School of Hygiene and Public Health, John Hopkins University, Baltimore, Maryland.

Table 4.1 Frequently occurring symptoms reported by chemically sensitive patients of Dr Ziem

Symptom	percentage of patients
nasal symptoms	60
sinus discomfort	48
throat discomfort	53
weak voice/hoarseness	44
chest tightness	42
wheezing	25
tremor or shaking	29
muscle twitching	33
memory problems	67
slurred words/difficulty finding words	58
coordination difficulties	49
reduced bladder control	27
flushing skin	39
rapid pulse	24
palpitations	25
reduced cold tolerance	31
reduced heat tolerance	24
changes in hearing	32
visual changes	48
ringing ears	36
swollen glands	21
muscle discomfort/spasm	49
joint discomfort	52
headache	57
unusual fatigue	69
frequent unusual thirst	40

Source: Ziem & McTamney 1997, p.421-3.

In addition to the symptoms reported by Ziem and McTamney, other writers have reported loss of concentration, nausea, odour hypersensitivity, dizziness, irritability, anxiety, depression, dry cough, transient urticaria, dry red skin, neuropathy, bloating, diarrhoea, renal pain, sleep disturbances (Levy 1997, p.70,72), and mood alterations and noise sensitivity (Miller & Mitzel 1995, p.125). Dr Grace Ziem noted, in 1994, that hyperactivity, attention deficit, and behavioural changes were common in children. Bell *et al.* (1997a, p.457-8) noted the frequent features of "feelings of unreality/spaciness and lightheadedness", menstrual disorders, irritable bowel, breast or ovarian cysts, panic disorder, and 'derealization' (in which familiar objects and people are perceived as being

unfamiliar). Bell *et al.* (1997a) reported the "bidirectionality of symptoms", i.e. a patient can at once suffer sleepiness and insomnia (p.458). A number of authors have also reported possible somatic reactions, i.e. physical manifestations of psychological disorders (e.g. Bell *et al.* 1997a; Levy 1997).

Prevalence of effects

Just as there are no definitive clinical criteria for MCS, there is also no definitive estimate of the percentage of the population affected by it. One of the earlier estimates is that reported by the Interagency Workgroup (IWMCS 1998, p.19) in which Mooser (1987) suggested that 2-10 percent of the general population may have "substantive disruption of their lives because of MCS".

Ashford and Miller (1991) reported on a 1987 workshop held by the US National Academy of Science which referred to the "'15 percent of the U.S. population [who] have an increased allergic sensitivity to chemicals commonly found in household products, such as detergents, solvents, pesticides, metals and rubber, thus placing them at increased risk [of] disease'" (p.xvi).[32]

Davidoff and Keyl (1996, p.202) reported on worker surveys in which 19 percent of organophosphate-poisoned workers,[33] 13 percent of solvent-exposed workers,[34] and 63 percent of 250 casino workers exposed to pesticide applications for cockroaches,[35] all became sensitive to a range of chemicals subsequent to the exposures. They also referred to a study by Bell *et al.* (1993a) of university students in which 15 percent reported being made ill by at least four of five chemical odours. The Interagency Workgroup (IWMCS 1998) reported on a second study by Bell *et al.* (1993b), which found 22 percent of young adult college students reported feeling "moderately or severely ill after exposure to at least three of five substances" (p.19). A third study of college students, by Bell *et al.* (1996), found that 28 percent considered themselves to be "especially sensitive to certain chemicals" (p.9), but only 0.2 percent reported physician-diagnosed MCS. Bell *et al.* (1997a) also reported on studies that found 60 percent of solvent-exposed industrial workers "manifested symptoms of illness from chemical odour" (p.458).[36]

[32] Workshop on Health Risks from Exposure to Common Indoor Household Products in Allergic or Chemically Diseased Persons, July 1, 1987. Board of Environmental Studies and Toxicology, National Research Council.
[33] Tabershaw & Cooper 1966.
[34] Gyntelburg *et al.* 1986.
[35] Cone & Sult 1992.
[36] Ryan, Morrow & Hodgson 1988; Morrow, Ryan, Hodgson & Robin 1990.

The Interagency Workgroup (IWMCS 1998) reported a study, by Baldwin *et al.* (1997), that found 22.7 percent of a "subset of urban employed persons" (p.20) as feeling moderately or severely ill after exposure to at least three of five substances, namely pesticides, paint, perfume, car exhaust, and new carpet.

In a survey of a rural population Meggs *et al.* (1996, p.276-7) found that 33 percent reported chemical sensitivity. Of these, 25 percent cited pesticides as producing symptoms.

In 1993 the California Department of Health conducted a telephone survey of 4,000 randomly selected California residents and found that 16 percent reported "sensitivities to everyday chemicals and 6 percent claimed to have been diagnosed with multiple chemical sensitivities by a doctor" (IWMCS 1998, p.21).

The evident summary of the above is that there is no clear estimate of the level of the general population that is affected by MCS, and that it ranges from 0.2 percent to 33 percent. The figures provided here, and elsewhere, need to be viewed in the context of the limitations of the studies, which are principally small sample size and no agreed case definition of MCS. An eye needs to be kept on the manner of reporting the incidence too: Meggs *et al.* (1996), reporting on their rural survey, gave the incidence of chemical sensitivity as being 33 percent in the abstract, and 4.1 percent in the conclusion of their paper, where the latter refers to near daily occurrence of symptoms and the former refer to symptoms over any time period. Bell *et al.* (1997a, p.458) provided an estimate, based on Meggs study and one of their own on elderly people,[37] that the prevalence of MCS ranges from 0.2 to 4 percent of the general population. They acknowledged that their own studies had showed self-reported chemical odour intolerance resulting in illness in 15-30 percent of subgroups of college students and elderly people, but appear to dismiss these findings as indicative of MCS in the general population on the grounds that neither of these groups are "MCS populations", i.e. those exposed occupationally to chemicals. They also dismissed the findings on the grounds that the people concerned did not perceive themselves as being disabled by chemical-related illness. Note that Bell *et al.* (1997a), in referring to the Meggs study, chose to use the figure for near daily occurrence, which seriously skews the degree of prevalence of MCS towards recognition of only the more serious end of the scale of disability. Similarly, the Interagency Workgroup (IWMCS 1998) reported the prevalence of MCS as ranging from 0.2 percent to 6 percent, based only on the figures for physician-diagnosed MCS and dismissing the

[37] Bell, Schwartz, Amend, Peterson & Stini 1994.

15 to 37 percent of self-reported adverse reactions to chemical odours as "not necessarily" (p.21) being MCS.

Effected groups

Ashford and Miller's proposal, that those most effected by MCS are those people who are occupationally exposed to hazardous chemicals, who occupy sick buildings, or who live in particularly contaminated communities, appears to be at odds with subsequent findings. Cullen and Redlich (1995, p.1812-3) found that females, white-collar workers, and others who experience minimal chemical exposure in their routine lives relative to occupationally exposed people, appear to be more susceptible. Lax and Henneberger (1995) are reported, by the Interagency Workgroup (IWMCS 1998, p.23), as finding that only 26 percent of MCS patients compared with 54 percent of non-MCS patients at an occupational health clinic, worked in hazardous industries. Whilst these findings are at odds with the predicted distribution of MCS, they are supported by the observation, by Au *et al*. (1999), of a higher incidence of inheritance of unfavourable alleles of the polymorphic genes responsible for metabolizing chemicals amongst Costa Rican farmers exposed to pesticides. This finding, they suggested, explained the healthy worker effect referred to earlier in this chapter and discussed in Chapter 3, section 3.5.3, of a lower overall mortality rate of workers exposed to hazardous agents, compared with the general population.

One of the very few aspects of MCS on which there appears to be general agreement is that there is a greater incidence of the problem amongst women than amongst men. In 1991 Ashford and Miller reported that 70-80 percent of cases are women, and most subsequent studies tend to confirm this finding. In 1990 Donald Black, Ann Rathe and Rise Goldstein (p.3169) stated that MCS patients are typically middle-aged, well-educated women, with an interest in emotional disorders and who have developed a lifestyle and friendships around their illnesses—implying that this indicates a pre-existing psychological gender-based disturbance or neurosis, rather than an outcome of an effect of chemicals, possibly unrecognized and misdiagnosed.[38] Levy (1997, p.71) noted that about 80 percent of MCS patients at his occupational medicine clinic are women, some of them young, well-educated, with good intellectual resources and who functioned well until chemical exposure. Meggs *et al.* (1996) pointed out that "the anecdotal observation that chemical sensitivity is a condition of educated, urban housewives was not supported by our study" (p.28), in which they found that chemical sensitivity was distributed evenly across racial groups, income levels and employment

[38] Black, Rathe & Goldstein, Department of Psychiatry, University of Iowa College of Medicine, Iowa City.

categories, and moderately elevated for women: 38.8 percent of women as opposed to 23.5 percent of men. Miller and Mitzel (1995) found, in a survey of 112 patients with MCS, that 80 percent were women. Of these, 83 percent suffered onset of symptoms after the age of 30 years, and 81 percent had been working full time at the time of onset. Only 12 percent were still employed when surveyed, the majority having quit work or changed jobs because of their illness. Thus Black *et al.*'s assertion that sufferers of MCS are predominantly middle-aged women inclined towards emotional disorders is confirmed by other writers only with respect to gender. The implications of middle-aged neurosis are not supported.

The Interagency Workgroup (IWMCS 1998), in acknowledging the preponderance of women amongst MCS sufferers, added that "the reasons for this preponderance are unknown" (p.24). However, Bell (1996, p.108) provided one possible clue. When reporting on studies on animals indicating that females are more sensitive to stress and drugs than are males, she commented that this is perhaps an effect of oestrogen. Evidence that oestrogen may enhance the effect of chemicals on the nervous system (Bell *et al.* 1997a, p.460) will be discussed later in this chapter.

4.3.3 Mechanisms

In 1997 Robert MacPhail described MCS as an "illusive phenomena" (p.455). In the same year Claudia Miller remarked upon the "vituperative professional disputes that surround it" (p.447). There are a number of identifiable reasons for this lack of scientific cohesion, quite part from the usual diversity of intellectual debate. A lack of verifiable dose-response relationships in the traditional toxicological sense, and in fact a negation of the traditional dose-response model (Bell *et al.* 1997a, p.458), must hinder the acceptability of a physiological basis for MCS in quite a few quarters. As intimated by Gots, previously in this chapter, part of the lack of recognition of the MCS syndrome also lies with the lack of defined and consistent biological markers for the identification of the condition (also Staudenmayer 1997, p.434; Cullen & Redlich 1995, p.1809). Steven Rowat's (1998, p.90) report of biomarkers such as immune system T-cell counts, which can show opposite responses in different people with MCS, underlines this problem.[39] Other authors have commented on the contribution of a lack of experimental data (Weiss 1997, p.487), the variability of symptomatology between people (e.g. Fiedler & Kipen 1997b, p.411) and the lack of agreement as to the exact mechanism of multiple chemical sensitivity. As the latter appears to cause the greatest problem, this section will

[39] Rowat, Grantham's Landing, British Columbia.

briefly review the main theories of mechanisms and models of action.[40] Of all the posited mechanisms, the traditional toxicologists (e.g. Timbrell 1995, p.146; Gallo & Doull, 1991, p.15) generally recognise only the role of allergic reactions, involving antibodies and other non-specific immunological factors, in individual sensitivity to chemicals. More recently, there has been increasing recognition of the role of metabolic factors in individual sensitivity (e.g. Hodgson & Levi 1996).

Metabolic

Early theories of the mechanisms of MCS centred on the approach of clinical ecologists, such as Dr Theron Randolph (1962) and Rea (1992), who placed emphasis on metabolic explanations. The response to a chemical exposure is said to involve enzymatic and non-enzymatic biochemical transformation processes, the nature of that response depending in part on the biochemical individuality of the person concerned. This biochemical individuality is affected by the person's genetic makeup, nutritional state and exposure to pollutants during gestation, their total body load of pollutants, and their current nutritional state, according to Rea (1992). A brief look at each of these may help to shed light on areas of omission in standard toxicological extrapolations.

Genetic makeup

One of the most vital aspects of genetic makeup is said, by Rea (1992), to be the presence or absence of specific enzymes required for detoxification. A failure to detoxify exogenous chemicals leads to the formation of free radicals. These trigger a release of inflammatory mediators which in turn cause the multitude of symptoms experienced by MCS suffers. Hodgson and Levi (1996, p.97-8) identified some of the enzymes involved in the metabolism of pesticides as being the cytochrome P450-dependent monooxygenase system, flavin-containing monooxygenase (FMO), prostaglandin synthetase, molybdenum hydroxylases, alcohol and aldehyde dehydrogenases, esterases, and a variety of transferases, most notably glutathione S-transferase. This aspect of the metabolic basis for individual sensitivity is well supported by writers outside of the realm of MCS, as has been previously reported in this chapter with respect to the healthy worker effect, and in Chapter 3 with respect to extrapolation from animals to humans and to sensitive humans (e.g. Au *et al*. 1999; Hodgson & Levi 1996; Porter *et al*. 1999; Lewis *et al*. 1998).

[40] The discussion on endocrine disruptors in Chapter 6 will reveal the importance of the clear definition of casual mechanisms for the acceptance, by positivist science, that a problem exists.

Rea (1992, p.36) asserted that virtually everyone has some sort of genetic deficiency and that over 2,000 genetic metabolic defects have been described in the literature.[41] For example, about 20 percent of the population are estimated to be "slow sulfonators", becoming ill when exposed to sulphur-containing substances such as *s*-carboxymethyl-L-cysteine, partially explaining, according to Rea (1992, p.38), their sensitivity to sulphur additives in foods.[42] Possibly, therefore, these people might experience increased sensitivity to sulphur-containing pesticides such as the sulphonylurea herbicides. Rea (1992, p.50,66,425) noted that many MCS sufferers have decreased levels of the enzymes superoxidase dismuthase, glutathione peroxidase, and catalase—all involved in detoxification of xenobiotics. Changes in the levels of other enzymes involved in detoxification, including lipid peroxidase, elastase, cytochrome P450 monooxygenase, and ketone reductases have been noted, or suggested as being implicated, in MCS patients (Rea 1992, p.418-25). Sixty percent of a group of MCS patients were reported to have cytochrome P450 system defects (Rea 1992, p.38).[43] Approximately 10 percent of the general population have been estimated to have a genetic deficiency of the cytochrome P450 system resulting in intolerance of debrisoquine compounds, which are anti-hypertensive drugs (Rea 1992, p.38).[44] Cullen and Redlich (1995 p.1810) also reported substantial differences within the population in levels of activity of enzymes such as N-acetyltransferase, P450 cytochromes, and glutathione transferase noting that, although these differences in genotype result in only a threefold or less difference in risk with respect to cancer, their role appears to be far greater in the idiosyncratic reaction to chemicals that typifies MCS. It is worth noting, however, that Graveling *et al.* (1999), in their review of MCS, omitted any mention of deficiencies in xenobiotic metabolizing enzymes as a possible cause.

Rea (1992, p.38) suggested that some people may be deficient in cholinesterase, and therefore more susceptible to organophosphate insecticides. He further noted that people who are homozygous (autosomal recessive) may not be able to metabolise the organophosphate parathion, a condition he referred to as serum paroxonase polymorphism (p.414). Cullen and Redlich (1995, p.1810) also stated that polymorphisms might result in differential responses to organophosphate insecticides. As mentioned earlier, exposure to organophosphates has been posited as possibly a major cause of MCS, so this type of genetic predisposition may be of importance.

[41] Rea cited NRC 1984.
[42] Rea cited Smith 1986.
[43] Rea cited Monro 1986.
[44] Rea cited Idle, Mahgoub, Lancaster & Smith 1978.

Total body load of pollutants

Rea included in the 'total body load of pollutants' such things as pollens, dust, moulds, food contaminants, parasites, chemicals, electromagnetic radiation and radon—foreign compounds that the body's detoxification systems must handle. Of particular interest are the organochlorine pesticides. Rea (1992, p.177) referred especially to aldrin, lindane, hexachlorobenzene, mirex and arochlor, inferring that the presence of residues in chemically sensitive people contributes to lowered functioning of their immune systems. He commented on the "extremely" high levels found in chemically sensitive patients at his Dallas Centre in the age range of twenty to thirty, especially those from Australia (p.910). He further reported that HCB and PCBs have been found in the blood of 51 percent of the chemically sensitive patients at the Dallas Centre. Of a group of forty hospitalised patients at Dallas, thirty-nine had measurable levels of pesticides in their blood, principally organochlorines (p.279). Unfortunately, Rea did not provide an analysis of the levels of these pesticides in the general population as a comparison.

There appears to be little available information on the role that body burdens of pollutants may play in the health of an individual. Some conflicting evidence exists that organochlorine residues in the body may be linked to breast cancer (Davis, Axelrod, Bailey, Gaynor & Sasco 1998), and to liver cancer (Cocco, Kazerouni & Zahm 2000). Graveling *et al*. (1999, p.76) made only passing reference to the involvement of body burdens in MCS, including that Albright and Goldstein (1992) "question the concept". However, Hansen *et al.* (1998, p.1272) provided a schematic spectrum of biological response to pollutant exposure, in which they considered the role of the body burden of pollutants. They stated that, as pollutant levels increase, the body may exhaust "its adaptive and compensatory mechanisms and its functioning could be compromised" (p.1272). They further add that because of the variation in biochemical characteristics, including enzyme levels, "a specific smaller fraction of the population may be hypersensitive to pollutant burdens and exhibit adverse responses to levels of exposure that may otherwise be considered low" (p. 1272).

Nutrition

The relevance of nutritional status to MCS lies primarily with the enzymes required for detoxification and their dependence on an adequate supply of vitamins, minerals and amino acids for proper functioning. Rea's book contained detailed information on the role of each of these nutritive elements in the biochemical processes and occasionally made links to pesticides—for example, the detoxification of sulphur-containing

insecticides can be impaired by lack of Vitamin B2 (p.250). Rea (1992, p.299,324) reported that 89 percent of randomly selected patients at the Environmental Health Centre-Dallas were found to be deficient in chromium, 40 percent in magnesium, 33 percent in sulphur, and other nutritive elements to varying degrees. Again, unfortunately, he did not compare these with the nutritive state of the general population. Cullen and Redlich (1995, p.1810) also noted the possible role of antioxidants *B*-carotene and selenium, and retinoids, in differential reaction to carcinogens.

In summary, the permutations and combinations of inherited and acquired enzymatic deficiencies, body burdens of pollutants such as organochlorine residues and viruses, and depleted nutritive states, could provide virtually infinite variation in the sensitivity of humans to chemicals. Such variation is not well reflected in the standardised inbred, or even outbred, strains of uniformly healthy white rats, fed standardised diets, that are used for laboratory toxicology studies. Further more, it would seem unlikely that this vast area of differences could be accommodated by a simple default factor of ten, as is attempted in standard risk assessment processes. Certainly there is no proof that it does. Conversely, although there is no proof that these factors cause multiple chemical sensitivity, there appears to be a reasonable body of evidence and opinion that they may make important contributions to an enhanced sensitivity of some peoples to chemical exposures.

Immune

Immune system based mechanisms for explaining multiple chemical sensitivity have also been favoured by clinical ecologists (Terr 1986, p.145; Brod 1996, p.203; Graveling *et al*. 1999). There are two types of immune system response suggested: that of an immunoglobulin IgE-mediated allergic reaction, involving the generation of antigen-specific lymphoid cells, and/or that of a non-specific immune response involving generation of macrophages, T-cells, mast cells, platelets (Ashford & Miller 1991; Brod 1996; Rowat 1998).

Chemicals may deregulate the immune system in two different ways: by suppression or by stimulation. A chemical may be immunosuppressive or immunoderegulative or both, depending on dose and individual characteristics of the recipient of that dose. Rea (1992, p.177) noted that organochlorine, organophosphate and carbamate insecticides are known to cause suppression of the immune system, via their effect on lymphocytes. He mentioned the carbamate carbaryl, and organophosphates formothion (Anthio),

malathion, leptophos, trichlorfon (chlorofos), and parathion as having been found to be involved in deregulation of the immune system (p.192).

Perhaps it is the ability of a chemical to effect the immune system in either direction, depending on the biochemical characteristics of the individual person concerned, that causes the conflicting results reported by so many studies, and which has lead to the discounting of a physical cause of MCS by some writers (e.g. Bock & Birbaumer 1997, p.482). Brod (1996, p.204) presented a summary of a number of these studies in which, for example, investigators have reported elevated levels,[45] or depressed levels,[46] or no abnormal changes in levels[47] of IgE; and increased T4/T8 cell ratios,[48] decreased T4/T8 cell ratios,[49] or no consistent pattern of abnormality in the ratio.[50] The variations in results may be partially explained by lack of standardised laboratory protocols, or differences in selection of case and control groups, according to Brod (1996, p.204-5). Rea (1992, p.203) reported the results of a large study carried out at the Environmental Health Centre-Dallas which showed increased T4/T8 cell ratios, except for patients with asthma, the latter result described by Rea as "puzzling" (p.197).

The non-specific immune response, coupled with a neural component, has recently found favour again with some researchers. Dr William Meggs (1997) proposed a mechanism for MCS that is based on the heightened, and eventually continual, inflammatory response of the upper airways, particularly nasal passages, to inhaled chemicals, with subsequent neurogenic switching to cause inflammation of other organ systems.[51] Meggs (1997, p.473) commented that it is the opinion of he and his colleagues that MCS is related through this process to the epidemics of asthma and arthritis, both of which are inflammatory conditions, in industrialised countries.

Graveling *et al*. (1999) concluded, after reviewing the literature, that "no consistent pattern of immune deficiency or other dysfunction can be identified among patients with MCS" (p.76), which in their view limits the plausibility of immunological deficits as the causal mechanism of MCS. However, another conclusion that may be drawn from the variety of results reported above is that, again, the standard toxicological approach

[45] Rea *et al.* 1978.
[46] Stricker 1994.
[47] Terr 1986; Fiedler, Maccia & Kipen 1992.
[48] Rea *et al.* 1986.
[49] Levin & Byers 1987.
[50] Terr 1986; Fiedler *et al.* 1992.
[51] Meggs, Department of Emergency Medicine, East Carolina University School of Medicine, Greenville, USA.

to extrapolating the effect of chemicals on healthy laboratory rats may not adequately reflect the variations found in the human condition.

Psychological

There is a considerable degree of both medical literature (e.g. Black *et al.* 1990; Rosenburg, Freedman, Schmaling & Rose 1990; Simon *et al.* 1993; Bock & Birbaumer 1997; Staudenmayer 1999) and non-medical comment (e.g. Shorter 1997) that views MCS as primarily or totally a psychological phenomenon involving somatization, rather than a purely physical phenomenon. Shaped Siegel and Richard Kreutzer (1997) suggested it may be all a matter of Pavlovian conditioning: the mere odour of an insecticide will trigger the avalanche of effects.[52] Other authors have also reported studies that indicate that MCS patients are responding only to odour and not to chemical (Staudenmayer 1997). Siegel and Kreutzer (1997, p.523) proposed counter conditioning as a treatment for MCS. Arthur Leznoff (1997, p.438) suggested MCS might be "a manifestation of an anxiety syndrome triggered by [the patients'] perception of an environmental insult, with at least some of their symptoms induced by hyperventilation" (p.438).[53] Herman Staudenmayer, Mary Selner and John Selner (1993a) suggested that the symptoms of MCS might be somatization as sequelae of childhood abuse.[54] Others believe that it is a simply a "belief system . . . which is reinforced by doctors, media and other institutions of society" (Brodsky 1984; Terr 1986; Staudenmayer, Selner & Buhr 1993b; Black 1996; Bock & Birbaumer 1997, p.481; Staudenmayer 1999).

Some of the belief that MCS is a manifestation of a psychological disorder stems from studies demonstrating a lack of evidence of physical causes, in particular a lack of immunological evidence (Terr 1986). Graveling *et al.* (1999) termed this a default assumption. Yet, for every study demonstrating a lack of physical evidence, it appears there is another demonstrating the existence of evidence. For example, Drs Martin Hahn and Herbert Bonkovsky (1997, p.281) reported that "there is no scientifically valid evidence to support an association between MCS and coproporphyria" (p.281), a metabolic disorder in which there is excessive urinary secretion of the respiratory pigments, porphyrins.[55] But Ziem and McTamney (1997, p.417) reported on several

[52] Siegel, Department of Psychology, McMaster University, Ontario; Kreutzer, Environmental Health Investigation Branch, California Department of Health Services.
[53] Leznoff, Division of Clinical immunology, Division of Occupational Medicine , St Michael's Hospital and the Department of Medicine, University of Toronto.
[54] Staudenmayer, Selner & Selner, Allergy Respiratory Institute of Colorado, Denver.
[55] Hahn & Bonkovsky, Departments of Medicine (both), and Biochemistry and Molecular Biology (Bonkovsky only), and the Center for Study of Disorders of Iron and Porphyrin Metabolism (both), University of Massachusetts Medical Centre, Worcester, USA.

studies that indicate chemical exposure *can* cause porphyrin disturbance, including abnormal levels of urinary coproporphyria, and backed these with results from their own study. Simon *et al.* (1993, p,97) reported that they could not find any immune effect in their case-control studies of MCS. Nor did Nancy Fiedler, Clement Maccia and Howard Kipen (1992).[56] But, again, Ziem and McTamney reported their own findings of immune disturbance in MCS patients, as well as those of other supportive studies. Rea (1992) also reported immune disturbances. Fiedler and Kipen (1997b, p.413) reported neurophysiological studies indicating that MCS is a psychosomatic disorder, but Ziem and McTamney (1997, p.418) reported similar studies indicating that MCS is a physiological not a psychology disorder, as did Gerald Ross (1997, p.439).[57] Davidoff and Keyl (1996) concluded that "in summary, our data appeared less consistent with currently formulated psychogenic models than with a biogenic model" (p.210). Fiedler *et al.*'s 1992 study also found MCS symptoms unrelated to any previous psychological or psychiatric history.

Few proper case-control studies of people presenting with MCS symptoms have actually been carried out, according to Fiedler and Kipen (1997b). In a review of those that have been carried out, they concluded that the "the most consistent finding is that chemically sensitive patients have a higher rate of psychiatric disorders across studies relative to diverse comparison groups" (p.409). However, the studies have failed to provide sufficient evidence of causality, according to the authors, although they note that "preliminary studies show neurologic, cognitive, and emotional symptoms are the best discriminator between MCS and normals" (p.411).[58] Most of the studies omitted patients who had psychological or pathological conditions preceding the onset of chemical sensitivity, even though such people are reported to have their conditions worsened by chemical exposure (Rea 1992).

Where case-control studies have been carried out, there is frequently disagreement over the interpretation and validity of results from the studies. In their case-control studies, Simon *et al.* (1993, p.97) and Black *et al.* (1990, p.3166) reported significantly higher rates of anxiety and depression amongst MCS patients than amongst control subjects, leading the second group of authors to conclude that psychiatric illness rather than chemicals may be the cause of the symptoms. These studies have been cited often by adherents of

[56] Fiedler, assistant professor and Kipen, associate professor, Department of Environmental and Community Medicine; and Maccia, clinical associate professor, Department of Paediatrics—UMDNJ-Robert Wood Johnson Medical School, Piscataway, New Jersey.
[57] Ross, Environmental Health Centre-Dallas, Texas.
[58] This comment was made in the context of the apparent failure to find a "coherent pattern of symptoms to distinguish chemical sensitivity" (Fiedler & Kipen 1997b, p.411).

the view that MCS is a disorder of psychological origin (e.g. O'Donnell 1993;[59] Gots 1993, p.23). However, Simon *et al.* (1993) also acknowledged that the significantly higher rate of psychological disturbance amongst MCS cases in fact "did not appear to precede the onset of chemical sensitivity" (p.97), and Black *et al.* acknowledged that their samples of case and controls may have been biased by their selection technique. The validity of Fielder *et al.*'s 1992 study, which did *not* find premorbid psychiatric disturbances amongst MCS patients, is challenged by Staudenmayer and Selner (1995), but defended by the authors (Fiedler & Kipen 1995) who noted that Staudenmayer and Selner did not apply the same critique to the data of Simon *et al.* (1993) and Black *et al.* (1990).

Black *et al.* (1990, p.3169) implied that a pre-existing psychological gender-based disturbance or neurosis renders women with an interest in emotional disorders susceptible to believing they have been adversely affected by chemicals. As previously noted in this chapter, women do indeed appear to be more susceptible to MCS than men, but to infer from this that the cause is psychological rather than physical is wholly without scientific merit, and the inference only serves to elucidate the underlying value systems of some researchers of the syndrome.

Dr Bruce Brod (1996), in his review of MCS, asserted that there have been "numerous published case studies [which] have strongly linked MCS syndrome to underlying psychiatric diseases" (p.202).[60] Brod backed this statement by uncritical reference to the studies of Black *et al.*, Simon *et al.* (even though these authors acknowledged that the psychological symptoms did not appear to precede the onset of MCS), and other studies by Brodsky (1994), Stewart and Raskin (1985), and Rosenburg *et al.* (1990). Brod did also refer to observations by Bell, Miller and Schwartz (1992) who had noted that psychiatric treatments do not improve symptoms in most patients with the MCS syndrome, and by Fielder *et al.* (1992) who found that the high incidence of anxiety and depression in patients did not predate the onset of MCS.

In summary, then, there seems to be general agreement that MCS patients show a higher than average rate of psychiatric symptoms, as differentiated from psychiatric disease (Kipen & Fiedler 1995, p.24). The real debate lies in two areas:

i. Did the psychiatric symptoms predate the onset of MCS, or were they a manifestation of MCS?

[59] Dr John O'Donnell, a clinical immunologist from Christchurch.
[60] Dr Bruce Brod, Medical College of Pennsylvania and Hahnemann University, Philadelphia.

ii. If the psychiatric symptoms did predate MCS, were the other symptoms of MCS merely a manifestation of a disturbed psyche (somatization) with chemicals playing no role at all? Or were the psychiatric symptoms factors that physically predisposed a person to an extraordinary sensitivity to chemicals?

Finally, the questions that need answering: have the investigators who attribute symptoms to a psychological cause conclusively ruled out possible chemical causes prior to making their diagnosis? Not according to Miller (1995, p.25). On the other hand, have MCS cases been 'objectively verified'? Not according to Selner (1995, p.25).

Neurological

Hypotheses of mechanisms involving the nervous system seem to be dominating the most recent writings on the subject of MCS. Dr Iris Bell and colleagues have proposed a model that may explain much of the psychological and somatic symptomatology that is cited, by opponents to the concept of MCS, as evidence of a psychiatric disorder rather than one caused by chemicals.[61] The model is one of neural sensitisation based on the olfactory-limbic system, and involving kindling and time-dependent sensitisation. The model proposes that molecules of a chemical inhaled through the nose are transported directly to the limbic system in the brain by retrograde transport via the olfactory neurones, for the olfactory system lacks a blood-brain barrier to screen out these molecules. Repeated intermittent exposure to chemicals leads to progressive sensitisation of the olfactory bulb, amygdala and hippocampus regions of the limbic system. This process may explain the reaction of MCS sufferers to olfactory stimuli with headaches, dizziness and nausea, a condition known as cacosmia. Cacosmia has been reported by a number of researchers (e.g. Fielder *et al.* 1992; Bell *et al.* 1995; Bell *et al.* 1996) and is regarded by the proponents of the psychological model as being evidence of psychological causes (e.g. Bock & Birbaumer 1997, p.482; Black *et al.* 1990; Simon *et al.* 1993).

Kindling refers to the changes in the electrical firing pattern of the limbic structures of the brain, stimulated by low level chemical stimuli in this instance, leading to epileptic seizures. Partial kindling, which is more likely in MCS than full kindling, leads to social behaviour changes and aggression. Pesticides are especially implicated in this process, as is the solvent toluene, according to Bell *et al.* (1997a, p.458). The authors cited studies

[61] Bell 1992; Bell *et al.* 1996; Bell 1996; Bell *et al.* 1997a; Bell, Rossi, Gilbert, Kobal, Morrow, Newlin, Sorg & Wood, 1997b.

implicating lindane and endosulfan in particular.[62] Bell *et al.* (1996, p.18) also cited a study implicating dieldrin.[63] Time-dependent sensitisation is a non-kindling type of neural sensitisation that involves progressive increases in responsivity to a given stimulus with the passage of time. The outcomes may be behavioural, neurochemical, immune or endocrine changes.

A wide range of agents can induce or modulate time-dependent sensitisation, including volatile organic agents, and it appears that other factors may enhance it.[64] These factors include oestrogen, which may account for the significantly elevated rate of MCS amongst women (Bell *et al.* 1997a, p.460), prior environmental exposures, and particular genetic susceptibility (Miller 1995, p.26). Cross-sensitisation may also occur between chemical stimuli and psychological stress (Bell *et al.* 1997a, p.460).

Miller (1995, p.26) expressed the view that the involvement of the limbic system and the neighbouring hypothalamus in the regulation of virtually very aspect of physiological and psychological function may explain the myriad of symptoms that are manifested in MCS, if chemical injury occurs in this region of the brain. This view is supported by Bell *et al.* (1997a): "limbic dysfunction could lead to polysymptomatic conditions involving neurobehavioural and somatic manifestations" (p.458), including depression and panic disorder. Anger, learning, memory, autonomic nerve activity, and pain are all seated in this area of the brain. According to Miller (1995, p.26), lesions in the limbic area may be associated with irrational fears, feelings of unreality, wishing to be alone, sadness and a feeling of being out of control of one's feelings and thoughts. Lesions in the septal area of the limbic system may cause hypersensitivity to physical stimuli, hyperemotionality, loss of motivation, and fear of unfamiliar situations.

Bell (1992) believed that both physiological and psychological factors are intertwined in MCS, as did John Salvaggio (1994), and she suggested that chemical sensitivities may result from an interaction between chemical exposures and psychological stress.[65] Bell noted, in 1992, that "genetically-based neurochemical and/or receptor vulnerabilities in the central and autonomic nervous systems would make certain subsets of the population more likely to experience adverse effects of low dose chemical exposures" (p.89). In fact, Bell (1992) noted, "one might expect individuals vulnerable to major psychiatric disorders to be among the most susceptible to low doses of those

[62] Gilbert 1992; Gilbert 1995.
[63] Burchfiel, Duffy & Sim 1976.
[64] Pesticides not specifically mentioned.
[65] Salvaggio, Tulane University medical centre, New Orleans.

environmental chemicals that could worsen their inherent dysfunction in brain chemistry, either by direct action or by activation of endogenous mediators" (p.92). Bell linked this with the reported findings of electroencephalographic studies that suggest chemical odours below the olfactory threshold do produce distinct EEG responses, worsened mood, and poorer performance on a visual search task in normally healthy people.[66] Therefore, she argued, even unperceived low concentrations of airborne chemicals could activate clinical MCS symptoms in someone with a neurophysiological or neurochemical predisposition to limbic system dysfunction.

Another perspective on the intertwining of physiology and psychology is provided by psychoneuroimmunology, in which interaction between nervous, endocrine and immune system is said to result in behaviourally associated changes in immunity, and immunologically associated changes in behaviour (Cohen, Kehrl, Berglund, O'Leary, Ross, Seltzer & Weisel 1997). Cohen *et al.* suggested interactions between stress and immunity as a possible mechanism of MCS.[67] Miller (1995, p.26) referred to the convergence of the immune, nervous and endocrine systems in the hypothalamus, and Bell *et al.* (1997b) reported that time-dependent sensitisation of the nervous system can lead to sensitisation of the immune function. It should be recalled from earlier in this chapter, section 4.2.1, that Porter *et al.* (1999) found a combination of endocrine, immune, and behavioural effects in rats exposed to low doses of mixtures of chemicals—indicating a possible convergence of these two areas of research.

Integrated defense systems

One of the most recent proposals, that of Rowat (1998), seems to provide a model for incorporating many of the other proposed mechanisms into one whole. Rowat's approach is based on "nonlinear interactions between linked homeostatic systems" (p.90). It utilises the concept of nine "integrated defense systems" (IDS) that co-ordinate the communications of the nervous, immune and endocrine systems, most of which have been referred to individually already in this section. These IDS are known as time-dependent sensitization, immune responses to antigens, non-specific immune responses, kindling, acute-phase responses, stress response, neurogenic switching, tolerance, and

[66] Lorig & Schwartz 1988; Lorig, Schwartz & Herman 1988; Lorig 1989; Lorig, Herman & Schwartz 1990; Lorig, Huffman, DeMartino & DeMarco 1990.

[67] Nicholas Cohen, Department of Microbiology and Immunology, University of Rochester, New York; Howard Kehrl, US EPA, North Carolina; Birgitta Berglund, Department of Psychology, Stockholm University, Sweden; Ann O'Leary, Department of Psychology, Rutgers State University of New Jersey; Gerald Ross, Environmental Health Centre-Dallas, Texas; James Seltzer, Indoor Hygienic Technologies, San Diego; Clifford Weisel, EOHSI, Rutgers State University of New Jersey.

traumatic dissociation.[68] According to Rowat (1998, p.86), all of these, with the exception of traumatic dissociation, are known to result from exogenous chemicals such as pesticides.

Rowat provided six alternative models for the production of multiple chemical sensitivity through interactions of the integrated defence systems. Three of these are of particular interest for pesticides:

Model 1A: pesticide damage to the CNS: in which some organophosphate and organochlorine pesticides are known to affect neurotransmitters and initiate kindling of the nervous system, where the same strength stimulus to the brain produces stronger and stronger effects, and overlaps with some of the other IDSs resulting in involvement of the immune and endocrine systems. The chances of these interactions occurring may be increased by three factors:

i. synergistic effects of pesticides with existing body burdens of chemicals such as DDT, PCPs, dioxins, etc;
ii. zinc deficiency, which may result in malfunction of the limbic system or damage to the hippocampus if the deficiency is gestational, or failure of the enzyme systems that deactivate chemicals;
iii. the pre-existence of traumatic dissociation: Rowat cited as support the study by Staudenmayer *et al.* (1993a) that indicated a higher level of childhood sexual and physical abuse among women reporting MCS.

Model 2A: a combination of chemical and stress overload: in which the model of susceptibility, sensitization, triggering and then spreading used by Miller and by Rea (1992) is adopted to explain MCS.

[68] * Time-dependent sensitization: mild chemical stressors induce physiological or behavioural effects, which strengthen as a function of time independent of the stressor.
* Immune response to antigen: generation of antigen-specific lymphoid cells.
* Non-specific immune response: generation of macrophages, T-cells, mast cells, platelets, etc.
* Kindling: neural processes that mediate lasting changes in brain function.
* Acute-phase response: release of macrophages, mast cells, prostaglandins, glucocorticoids and other chemical messengers.
* Stress response: generation of neural, endocrine and immune chemical messengers.
* Neurogenic switching: rerouting of a sensory impulse from the site of activation via the central nervous system to a second location.
* Tolerance: development of immunity to persistent insult, i.e. repeated exposure to chemicals, may result in masking of symptoms.
* Traumatic dissociation: a conceptual mechanism for coping with overwhelming trauma, involving brain, endocrine and immune systems.

Model 3: MCS as learning and evolution: in which it is proposed that the neuroendocrine and immune systems are capable of learning from experience and adapting accordingly. In an individual sense, such learning may explain the apparently unsupportive case-control studies in which patients have been found to react to odour, or lack of it, rather than to a chemical itself:

> According to the models developed in this paper, odour may be linked in the patient's memory with acute unpleasant experiences, and by an associated IDS linkage (such as traumatic dissociation) may cause multiple reciprocal CNS-immune messengers . . . to cascade and perhaps lead to the stress response.
>
> Rowat 1998, p.98.

Rowat (1998, p.98) suggested that, in a species sense, MCS may be seen as a healthy evolutionary response to an unhealthy environment. People who suffer from MCS tend to remove themselves from contact with chemicals that are potentially damaging to their health and to their ability to produce healthy progeny. In this light, argued Rowat, "such a difference could be viewed as an improvement in the species" (p.98).

In conclusion, the main theories relating to the causative mechanism of MCS have been reviewed. Two others have not been reviewed because they add little to the debate. That is not to say they are not worthy theories, but rather to conclude that they will not assist the policy process. The two theories are Miller's TILT, or toxicant induced loss of tolerance (Ashford & Miller 1998), and that of chemically-induced porphyria, a deficiency of specific enzymes in the biosynthetic pathway for haem (Matthews 1998; Ashford & Miller 1998). Graveling *et al*. (1999) noted that neither of these theories provides an adequate explanation of MCS. It is worth noting that Matthews asserted that there are more than 3,000 known porphyrinogenic substances, which include unspecified pesticides as well as industrial and household chemicals (p.40,45). It is also worth noting that haem is a component of cytochrome P450, the enzyme system involved in the detoxification of xenobiotics such as pesticides, as already discussed. Hence, the subject of porphyria is entwined with that of metabolic functions and genetic susceptibility.

None of the theories found support with reviewers Graveling *et al*. (1999) as such, although they acknowledged the existence of the syndrome, in at least some people, and viewed Bell's theory of neural sensitization and limbic system involvement as the most strongly supported by available evidence (p.73). The purpose of the review in this thesis is not to solve the questions over the exact mechanism(s) underlying the syndrome, but

rather to look at the implications for pesticide policy and in particular that part of it which is based on toxicology.

What is particularly interesting about the integrated defense system proposed by Rowat, is not so much that it combines elements of most or all of the other theories, but rather the similarity to recent views expressed by researchers into the effects of low dose exposure to chemical mixtures. Several of these researchers have drawn together the effects of pesticides on the immune, endocrine and neurological systems (e.g. Porter *et al.* 1993, p.17; Carpenter *et al.* 1998; Porter *et al.* 1999; Guillette *et al.* 1999).[69] Concern is expressed particularly about potential effects on children, which may increase risk of chronic diseases later in life (Landrigan *et al.* 1999 p.434), and even cause transgenerational effects (Hansen *et al.* 1998, p.1271). The concern regarding children stems from an increasing awareness of the effects of pesticides on developing immune and neurological systems (Hansen *et al.* 1998, p.1272), compounded by their relatively greater exposure to pesticides (Eskenazi *et al.* 1999, p.409). Attention is particularly drawn to the adverse developmental effects of organophosphate insecticides (Eskenazi *et al.* 1999; Landrigan *et al.* 1999). Similarly, a number of MCS writers have posited that organophosphates may play a major role in the onset and triggering of MCS.

Conclusion

Several writers have made quite telling statements regarding toxicology and MCS:

> According to toxicology, a toxic effect of a substance is the same for all individuals, albeit at potentially different concentrations. Therefore, the effects of any given chemical in a patient with MCS syndrome should be both predictable and reproducible based on the response of a normal individual to higher concentrations.
>
> Brod 1996, p.203.

Quite clearly, from the brief overview presented in this chapter, that is not the case with MCS. A multitude of different effects may be experienced in reaction to a chemical, those effects varying from person to person. Sparkes, Daniell, Black, Kipen, Altman, Simon and Terr (1994, p.718) commented that "MCS does not appear to fit established principles of toxicology" (p.718).[70] It follows that either MCS does not exist, as a reaction

[69] Porter *et al.* (1993) cited Lloyd 1987 and Colborn & Clement 1992 as support for the contention of an intimate association between the endocrine, immune and nervous systems.

[70] Patricia Sparks, Providence Medical Centre, Seattle; William Daniell, Occupational Medicine Program, University of Washington School of Medicine, Seattle; Donald Black, Department of Psychiatry Administration, University of Iowa Hospitals and Clinics; Howard Kipen, Environmental and Occupational Health Sciences Institute, UMDNJ-Robert Wood Johnston Medical School, Piscataway;

to chemicals, or there is a fundamental problem with toxicology. This view was also put by Selner:

> If you agree with the principles of toxicology that I have enumerated today, then I think you will have to agree with me that there is no such thing as multiple chemical sensitivity.
>
> Selner 1995, p.24.

Conversely, if the existence of multiple chemical sensitivity is acknowledged, then by Selner's criterion, it would have to be agreed that there is a gap in the understanding of toxicology and perhaps a fundamental flaw in its principles. It is the defining principle that is at stake, 'the dose makes the poison', and in particular the assumptions that a 'safe' dose is safe for everyone, and a higher dose is more poisonous than a lower dose. Several writers on MCS have noted the problem with the traditional dose-response relationship with respect to solvents. Levy (1997) commented that "there is no verifiable dose-response relationship" (p.72) even though there seems to be an indisputable exposure-effect relationship. Cullen and Redlich (1995) stated that "the nonhomogeneity of human populations renders precarious the establishment of a single-dose-response curve for a population" (p.1809). Bell *et al.* noted that:

> MCS . . . defies traditional dose-response relationships of toxicology. That is . . . low doses trigger large responses.
>
> Bell *et al.* 1997a, p.458.

It will be remembered, from the previous chapter on the toxicological assessment of pesticides, that risk is regarded as being a function of hazard and exposure, where hazard is the intrinsic toxicity of the pesticide. But Miller (1997) stated that, in reality, there is another factor to risk—and that is the interaction of the pesticide with the person. That interaction depends upon a number of variables including genetic predisposition, nutritional and disease status, previous exposure to chemicals, and psychological stress. This view strikes accord with that expressed by Renn (1992) and also quoted in Chapter 3: that risk contains three elements rather than two, those three elements being undesirable outcomes (hazard), possibility of occurrence (exposure) and *reality.* That third element is given small credence in regulatory toxicology, yet it would seem that it is the absence of this that would account for the failure of the traditional dose-response relationship, especially with respect to multiple chemical sensitivity.

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Injection of that third element, Renn's reality, into the risk equation is also required to accommodate the potential interactions of low dose exposure to mixtures of chemicals. Injection of reality into the risk equation may allow toxicology to better serve policy requirements.

The syndrome of MCS throws other aspects of the traditional toxicology-based risk assessment paradigm into question as well. The second tenet of risk assessment, after 'the dose makes the poison', is that exposure makes the risk. Therefore, logically, those who are most exposed are at greatest risk, thus exposure assessment studies are carried out on workers. Yet, Cullen and Redlich made the interesting observation that:

> It seems likely that individuals with long-standing exposure to chemical environments are at somewhat lower risk than white-collar workers and others who experience minimal chemical exposure in their routine lives.
>
> Cullen & Redlich 1995, p.1812-3.

This statement is supported by the healthy worker effect reported in this, and the preceding, chapters.

Cullen and Redlich (1995) regarded MCS as "one of the major scientific challenges of environmental science", with research remaining "at the earliest phase" (p.1812-3). The mechanisms of action are not fully understood. Biomarkers to provide clinical diagnosis have not been fully elucidated. The extent of its existence is far from accurately estimated. As a result, many investigators have concluded that:

> Patients suffer only a psychological disturbance, with phobic responses to chemicals and a high degree of somatization of psychic distress. This interpretation is particularly attractive to toxicologists who can find no biological basis for reactions to such diverse chemicals affecting so many organ systems at such low concentrations.
>
> Cullen & Redlich 1995, p.1812.

Other writers have observed that whatever the cause of MCS, be it biogenic or psychogenic, the end result is significant disabling of a significant sector of society, with attendant economic implications. That makes MCS, as it relates to pesticides, an important issue of public policy, as well as one for scientific investigation. The so-far failure of science to fully elucidate the mechanism(s) involved in multiple chemical sensitivity means that the slavish adherence to toxicology for the provision of policy direction relating to pesticides must be seriously questioned. When the failure of toxicology to adequately identify effects of everyday exposure to mixtures of chemicals

are added to the problem of MCS, it becomes apparent that to rely on that science to provide information about acceptable levels of exposure to pesticides is without validity.

Thomas Kuhn is well known for his exposition on paradigm shifts and the intransigence of orthodoxy towards changes to the currently accepted scientific models in the period preceding such a shift. It was suggested earlier in this chapter that the dose-response model of toxicology may undergo a paradigm shift. Ashford and Miller (1998) also evoked the Kuhnian approach (p.286-7), suggesting that "chemical sensitivity could be a new paradigm for disease that has the potential to explain many chronic and costly illnesses, including fatigue, depression, headaches, and asthma" (p.205). They suggested that the critics' "intractable belief in dominant medical models" (p.287) retards progress towards a new understanding.

Ashford and Miller have noted the influence of those who reject a biogenic basis for multiple chemical sensitivity on public policy, referring to "those who continue to promote untested and untestable psychogenic theories for MCS" as "part of the problem" (p.256):

> Their lobbying of policy makers and others in this regard has contributed to widespread governmental inertia on this issue, making it near impossible to obtain funding for essential studies specifically directed towards MCS. Many of those who advocate psychological explanations in government-sponsored meetings and in the scientific literature are paid corporate spokespersons or consultants with financial conflicts of interest. . . . Policymakers and publishers of scholarly journals need to recognize and remedy this appalling injustice.
>
> Ashford & Miller 1998, p.256.

Dr Ronald Gots, who has shown a tendency to indulge in emotive language with respect to MCS, referring to it in 1995 as "a peculiar manifestation of our technophobic and chemophobic society" (p.111), nevertheless has recognised the importance of the issue to public policy.[71] He reported that it has been formally recognised as a compensable disease by the state of New Jersey and by the New Hampshire Supreme Court. It was also recognised in 1991 as a disability under the Americans with Disability Act. The Interagency Workgroup 1998 draft report listed a number of U.S. legal and government

[71] Dr Ronald Gots, President, National Medical Advisory Service, Maryland. According to Peter Montague of the Environmental Research Foundation, the National Medical Advisory Service provides expert witnesses to defend chemical corporations in tort lawsuits. Gots also heads the Environmental Sensitivities Research Institute, which is financed by pesticide companies DowElanco and Monsanto, pharmaceutical company Proctor and Gamble, and the Cosmetic Toiletries and Fragrances Association. Gots has published no original peer reviewed research on MCS (Montague 1998).

actions relating to MCS starting as far back as 1979, with the US District Court for the District of Hawaii ruling that MCS is disabling and ordering disability benefits be paid. Other disability payments followed. Court rulings in California, Ohio and other jurisdictions found MCS to qualify as a handicap. In 1994 Washington State passed legislation that funded several medical centres for the diagnosis and treatment of MCS, and in 1996 provided US $1.4 million for research (IWMCS 1998, p.18).

A number of workshops, conferences, fora, etc have been convened over recent years to review MCS, mainly in the United States, but some also in Europe. The key recommendations of a number of these were reported by the Interagency Workgroup. All of these recommendations related to further studies, research, surveys, development of new models and techniques in order to elucidate the situation, as well as acceptance of an agreed definition of, and criteria for, the syndrome. The report provided few recommendations about how other aspects of public policy shall proceed in the intervening, and no doubt lengthy, period during which this research is carried out. The report referred to the scientific uncertainties and unclear public health relevance (IWMCS 1998, p.71), the "inadequacy of scientific literature to enable the determination of the associations between human exposure(s) to chemicals in the environment and the development or exacerbation of MCS" (p.73). It acknowledged that "many chemicals have well-established toxicologic and allergenic properties; undoubtedly, others will be found to have adverse effects in the future" (p.73-4). The report acknowledged that "it is appropriate for public health leadership to work to mitigate illness in persons with disorders that are not yet fully explainable" (p.68). It acknowledged that "scientific knowledge changes over time as additional findings are reported; *it is therefore important not to lose sight of lessons from the past in which suspected health effects of environmental exposures were verified at a later date*" (p.69) [emphasis added]. But the report did lose sight of the lessons from the past—for its only recommendations relate to more research, better coordination, and an overall strategic plan. In other words, it is business as usual until MCS can be definitely proven. Thus, the benefit of the doubt is given to the chemicals, or rephrased: greater value is attributed to the assumed benefits of the chemicals rather than to the health of the public.

William Custer (1996) drew attention to the fact that, whilst science remains in a state of uncertainty, life goes on, including legal life.[72] The Courts continue to make decisions on compensation claims, those decisions sometimes becoming legal precedents, but always being interpreted as validation of the arguments of whichever side wins. He was

[72] William Custer of Powell, Goldstein, Frazer & Murphy, Atlanta, Georgia.

particularly concerned about the influence of these decisions on policymakers in the absence of scientific certainty. Thus, whilst the research continues, the data is gathered, the hypotheses tested, policymakers are left with the decision of whether to assume that multiple chemical sensitivity is an effect of pesticide exposure, or to assume that it is not. Policy-makers must also consider the current knowledge about, and evidence of, the actual and potential effects of everyday exposure to low doses of chemical mixtures, together with the failure of the toxicological risk assessment process to incorporate this information.

By now, policy development has reached a critical point. Should it rely only on the toxicological risk assessment process, a process that has been shown to be guided by a particular set of values and worldviews, and which has been shown to be unable to explain and incorporate human experience? Or should it instead be guided by human experience, using the scientific process to advise that development where it is able to do so, with full acknowledgement of the values on which it is based and *not* to determine the outcome of decisions. It is contended that it is the task of pesticide policy to reflect the reality of human existence, whether or not this reality can be validated by scientific positivism.

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Chapter 5 Rival Rationalities in Pesticide Policy: Technological versus Ecological

> In Buddhism, the most important precept of all is to live in awareness, to know what is going on . . . not only here, but there. For instance, when you eat a piece of bread, you may chose to be aware that our farmers, in growing the wheat, use chemical poisons a little too much. Eating the bread, we are somehow co-responsible for the destruction of our ecology.
>
> Thich Nhat Hanh 1987, p.65-6, cited in Korten 1998, p.146.

Introduction

In the preceding two chapters the process of technical risk assessment was examined with respect to areas of uncertainty, subjectivity, underlying value bias, and depiction of the human experience. The focus was intentionally placed on human health, with little information provided about environmental effects and assessment, for two reasons. The first of these is the comparative wealth of information relating to human health and hence the greater ease with which the inadequacy of the assessment process can be identified. Problems identified with respect to human risk assessment can be broadly assumed to exist with respect to environmental risk assessment, for it is only very recently that the latter has been incorporated into pesticide policy processes, as was indicated in Chapter 3.

The second reason in fact gives rise to the first. Over much of the last millennium human endeavour, at least in western nations, has been guided and directed by a set of values that have become embedded in science, risk assessment, and public policy. Those values have placed humans apart from, and above, the environment, and then attempted to manipulate the environment to human ends. Throughout the centuries many people have challenged this value structure and have proposed alternatives, but frequently their views have been cast into the backwaters of philosophical writing and rarely reached the public policy process. However, in the last few decades, a shift in value structures has seen a gradual re-emerging and redefining of some of those concepts, and their tentative inclusion in international fora and treaties[1] and in domestic laws such as the RMA 1991 and the HSNO Act 1996. Pesticide policy in New Zealand, however, has not yet grasped the significance of these concepts. In order for policy to incorporate ecological concepts, it is necessary to understand, not only the concepts themselves, but also the differing

[1] For a discussion of these see section 5.2.

approach to rationality that is called for. Hence, this chapter begins with a brief account of the emergence of the scientific/technical ethic and the form of rationality that drove it to its present day dominance in policy processes. This is followed by a brief analysis of the concepts underpinning ecological rationality and ecological ethics, including a broad outline of the current approach to the delineation of environmental effects of pesticides. These two accounts will help elucidate the nature of the differences in risk assessment between those whose worldviews were broadly characterised in Chapter 2 as egalitarian on the one hand, and technological enthusiasm on the other.

It will be argued that an ecocentric ethic provides a more rational, and ethical, basis for pesticide policy than does the technological ethic that currently underpins such policy. The chapter will conclude with an outline of how a pesticide policy can be derived from an ecocentric ethic, thus beginning the development of an ethical pesticide policy. That development will be continued in the next chapter with an analysis of which systems of knowledge should be admitted to the process, then completed in Chapter 7 with a determination of who should be making pesticide policy decisions.

5.1 Technological rationality

The subject of rationality has been a sub-theme running throughout this thesis, for understanding the nature of rationality and its relationship to social values is vital to pesticide policy. Instrumental, utilitarian rationality, of which risk assessment is an example, takes a problem-solving approach to issues, involving the minimizing of certain costs and the maximising of net benefit. In so doing it tends to reduce social questions of values to technical matters. Scientific rationality is claimed by its proponents as being the *only* rationality for it is seen as being objective, neutral and value-free, specifically because it avoids those questions of values and social issues. All that is not objective or free of values therefore becomes irrational. Science is often criticised for exactly that failure to account for needs, emotions and values, those characteristics of social issues around which public policy generally revolves. But, as has been demonstrated in the analysis of toxicology, scientific rationality is not neutral and it is not value-free. In fact the development of toxicology, and science in general, has taken place not in the absence of needs, emotions and values, but rather by assuming and incorporating a particular set of values that place greater store on a particular worldview. What that worldview is will be explored in this chapter, and the issue of objectivity will be given further treatment in Chapter 6.

Some writers encapsulate the worldview of modern science as that of 'the domination of nature'. William Leiss chose those words as the title of his 1972 analysis of the underlying causes of global environmental problems.[2] Others, including ecofeminist writers such as Indian physicist and philosopher Vandana Shiva, added a gender perspective to the analysis:

> During the last few years feminist scholarship has begun to recognise that the dominant science system emerged as a liberating force not for humanity as a whole (though it legitimised itself in terms of universal betterment of the species), but as a masculine and patriarchal project which necessarily entailed the subjugation of both nature and women.
>
> Shiva 1989, p.15.[3]

Historian Carolyn Merchant (1980, p.164-72), in her searching analysis of the relationship between women, nature and the scientific revolution, drew attention to the influence of the sexual politics of the time on the work of one of the founders of modern science, Francis Bacon. Kevin O'Connor and Peter Espie (1996), in paying tribute to Merchant's work, referred to Bacon and Isaac Newton as those who "sought to know nature's secrets and to exercise power over nature, rather as they were wont to exploit woman" (p.16).[4] Further, they acknowledged a "growing need for both the planet and humanity that this attitude should be forsaken, even renounced, in favour of cultivating by a different style of science, a more nature-respecting cooperation and coexistence" (p.16). These views become important in the context of some of the factors highlighted by cultural and social analysts of risk as underlying the differences between scientific and social rationalities—namely gender, race and worldviews such as attitude towards the environment and humanity's relationship to it. Evidence of the importance of these factors in societal assessment of pesticides was provided in Chapter 2.

If policy development is to be based on democratic principles, then the use of science in that process must be grounded in an understanding of the historical roots of scientific philosophy, acknowledging the involvement of value systems, and providing protection from the "tunnel vision that all too often ignores the larger consequences of gaining and applying knowledge" referred to by Rudi Volti (1995), and regarded by him as resulting from the "abstraction or isolation of the part of the natural world that

[2] Leiss, Research Chair in Environmental Policy, School of Policy Studies, Queens University, Canada.
[3] Shiva, Director of the Research Foundation for Science, Technology and Natural Resource Policy, Deharadun, India.
[4] O'Connor, Centre for Mountain Studies, Canterbury, New Zealand; Espie, Invermay Research Station, AgResearch, Otago, New Zealand.

is being studied or manipulated" (p.13).[5] Therefore, a brief, selective review of certain aspects of the so-called 'scientific revolution' of the late 16th to early 17th centuries that are relevant to today's pesticide policy debates becomes useful in providing contextual background for an understanding of the rationality of worldviews, those that underpin science and those that underpin both an ecological perspective and social rationality. It is not the intention to provide here an in-depth analysis of the history of scientific endeavour, but rather to illustrate the role of value systems in the formation of the scientific philosophies upon which today's pesticide policies are based. Science, as a study of the natural world, existed long before the scientific revolution and, throughout its history, social values and religious views have formed an important part of its guiding philosophies. But it is the changes in thinking that took place during the 16th and 17th centuries that are of the greatest interest here, for the resulting philosophy still today dominates science and policies derived from science, especially those based on risk assessment. Current pesticide policies are embedded in the philosophy of the scientific revolution, and as public policy generally increasingly embraces science, cementing it as the bed rock of decision-making in a way that enables social issues to be circumvented, it becomes necessary to elucidate the nature of that so-called revolution.

5.1.1 An abbreviated history of mechanistic natural philosophy

Steven Shapin (1996, p.3) referred to the scientific revolution as a re-ordering of philosophic thought about the nature of the natural world and 'man's' relationship to it.[6] The defining, and enduring, philosophy to emerge from this period is known as mechanical philosophy, in which the understanding of nature was modelled on the actions of man-made machines—hence mechanistic science. A fundamental methodological assumption of mechanistic science is that nature can be broken down into parts, just as a machine can be, and that the parts can be analysed individually, manipulated under the guidance of a set of rules, and then be assumed to provide the answer for the whole, thus the commonly used reference to modern science as 'reductionist'.[7] Francis Bacon, a leading light of the mechanistic approach, took the view that "the artificial does not differ from the natural in form or essence" (Shapin

[5] Professor Volti, Scholar in Residence, Pitzer College, USA.
[6] Shapin, Professor of Sociology, University of California, San Diego.
[7] For example, Merchant (1980, p.252) and Shiva (1989, p.21-2). A number of eminent scientists from disciplines ranging from cosmology to biological sciences acknowledged the reductionism of modern science in interviews with John Horgan (1996).

1996, p.31). This view was apparently also that of Rene Descartes (1596-1650): "all that is artificial is also natural" (Shapin 1996, p.32).[8]

A natural progression of this view of nature as being the same as man-made artifices, was the overturning of the pre-Socratic concept of the superiority, indeed divinity of nature, and its replacement by the concept of man's [sic] superiority and ability to control nature (Sessions 1991, p.141). The overturning of the pre-Socratic nature-oriented view by the mechanistic view also neatly endorsed the Christian belief in man's [sic] 'God-given' right to dominion over nature.[9] In this way the mechanistic view at once brought about a depersonalization of the knowledge of nature and with it a growing separation of humanity from its surroundings. Merchant (1980) pointed out that this mechanistic view of nature provided freedom from "the ethical strictures associated with the view of nature as a living being" (p.111), a freedom that resulted in the removal of societal controls over environmental exploitation. Although Frances Bacon was only one of a number of scientists involved in the development of mechanistic science, he is widely regarded as one of the most influential, particularly with regard to the idea of man's [sic] mastery over nature—Leiss (1994, p.xviii,48) credited Bacon with being the first to fully and clearly articulate this notion.

Another extension of this mechanistic philosophy was that of the "mechanisation of knowledge" (Shapin 1996, p.13), a drive to make knowledge conform to clearly laid out principles. The end goal of this process was to develop a body of scientific fact that was collected and collated without political, moral or social reference, hence was truly objective and value-free. In fact, Shapin (1996, p.162) stated that it was during this period of history that the understanding of science as value-free, outside the realm of morality or politics, was developed. To this day, the belief in the objective and value-free nature of science persists in many quarters. But in the very attempt to create this value-free body of science, Bacon failed to see the immense effect of his own social and religious views. Or perhaps he did recognise the effect, as charged by Shiva:

[8] This particular worldview takes its place today in pesticide toxicology, and is illustrated by the belief of those such as Bruce Ames that there is no difference between toxicants produced by nature and found in our food and toxic chemicals produced by man and added to our food (Ames, Magaw & Gold 1987; Ames, Profet & Gold 1990a, 1990b). This argument is used as a rationale for the acceptance of pesticide residues in food.

[9] ". . . God said unto them, Be fruitful, and multiply, and replenish the earth, and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth" (Genesis I:28). Interestingly, another section of the Bible portrays quite a different approach, that of interconnection and parity between humans and animals: "For that which befalleth the sons of men befalleth beasts; . . . as one dieth, so dieth the other; yea they have all one breath; so that a man hath no preeminence above a beast" (Ecclesiastes III:19).

> The mechanistic school represented by Bacon created dichotomies between culture and nature, mind and matter and male and female, and *devised conceptual strategies* for the former to dominate over the latter" [emphasis added].
>
> Shiva 1989, p.20.

For with the mechanisation of knowledge came also the securing of scientific knowledge as the proper realm of only the few, the experts, the elite (Shapin 1996, p.134). Those elite, in the time of Frances Bacon, one of the main progenitors of the mechanisation of knowledge, were men and specifically gentlemen who would conform to the rules of gentlemanly behaviour, and who usually were also in the social position of being able to elicit 'interest' at Court. The elitist approach to the acquisition of knowledge still persists, knowledge still being regarded as the realm of the 'expert'. If a person cannot be identified as an expert through conformance to strict criteria for knowledge gathering, such as application of reductionist scientific techniques, then her/his knowledge is likely to be discounted if it conflicts with that derived using those techniques.[10] Although today's world sees less chauvinism in the gathering of knowledge than in the days of Bacon, the original principles behind that gathering, and use, were developed solely by males for males in the 15-16th centuries, and they remain unchanged. Professor Dale Jamieson had this to say about the practice of science today, at least in the USA:

> Science, as it is practised in American society, is an elite institution, to a great extent self-governing, with primary allegiance to its own internal values. While many people have access to the deliverances of science, very few people are involved in the production of science, and scientists themselves are overwhelmingly white, male, and upper middle class.[11]
>
> Jamieson 1996, p.42.[12]

[10] It is precisely this problem that will be addressed in the next chapter.

[11] Couchman, Warren, Neil and Harper (1990) provided information on gender distribution of scientists in New Zealand that tends to support the general direction of this comment. They reported that in 1988 there were 672 female employees (p.3) and in the following year 1792 male employees (p.7) of the Department of Scientific and Industrial Research. They found that 85 percent of male employees were in the scientist and science technical classes compared with only 55 percent of female employees, and that conversely men were under-represented in the clerical class (p.114). They also found that Māori men were "badly under-represented" (p.xvii), comprising only 2 percent of staff compared with 8 percent of the overall male workforce. On the other hand, other ethnic minorities were "over-represented" (p.xvii).

[12] Jamieson, Professor of Philosophy, University of Colorado, Boulder; and adjunct scientist in the Environmental and Societal Impacts Group, National Centre for Atmospheric Research, USA. Confusingly, Jamieson advocates the maintenance of scientific authority and closer contact between science and policy making. His position is given greater discussion in Chapter 7.

That knowledge is power was well recognised in the 16th century. So too was the desirability of maintaining that power through controlling knowledge. Shapin (1996, p.124) acknowledged the powerful interests vested in scientific consensus, in the control of the criteria for right thinking, and in the control of whose knowledge is legitimised and how—then and now.[13] He referred also to what was seen as being the social danger of private belief:

> If uninstructed individuals believed just what they liked, with no external authority to judge whether the beliefs were valid, then disorder would be the consequence. The experimental community, however, had shown itself able to do the job of intellectual policing effectively.
>
> Shapin 1996, p.154-5.

Just as Bacon's social views are revealed by his championing of the gentlemanly elite as the proper repositories of knowledge, so too his religious views are revealed by his publication *The Great Instauration*. In this treatise he identified his belief that the new mechanistic natural philosophy would enable humanity to restore its lost technological control over nature, that loss of control being the original cause of the fall from grace in the Garden of Eden (Shapin 1996, p.139). His scientific pursuits involved a Christian religious duty, echoing the prophecy in the *Bible*'s Book of Daniel (II:38), of God's return when humankind had 'regained' control of nature.[14]

Leiss (1994, p.32,48) linked Bacon's notion of mastery of nature primarily to this Judeo-Christian tradition. Merchant (1980) linked it to gender politics, in particular a "patriarchal structure of family and state" (p.164) together with the submission of, and violence towards, women that was epitomised by the inquisition of witches at that time. Using female imagery, Bacon, she claimed, "developed the power of language as [a] political instrument in reducing female nature to a resource for economic production" (Merchant 1980, p.165). Bacon spoke of taking nature by force "to bind her

[13] Interestingly Paracelsus, whose principles so dominate toxicology today, espoused not the elitism of scientific knowledge, but rather the freedom of the lay person to study nature and acquire knowledge—he acquired his, not from experts, but from ordinary people and the environment about him (Merchant 1980, p.120).

[14] It should not be assumed that this interpretation of the Bible exhorting mastery over nature is the only interpretation. Connelly and Smith (1999, p.11-2) described a co-existing view in which Genesis is interpreted to mean that God exhorted humanity to assume a role of stewardship, of gardeners in the Garden of Eden. This approach, described by the authors as "weak" or "enlightened anthropocentrism" is much more mindful of environmental values, and has "moved to the centre of modern Christian thinking" (p.12). See also Callicott (1994, p.14-24) and Vaney (1993). However, whilst this approach now informs modern environmental legislation and some branches of science, it was the domination interpretation that guided the development of modern science.

to your service and make her your slave" (Farrington 1964, p.62).[15] He referred to matter as a "common harlot" (Merchant 1980, p.171). Other examples of Bacon's use of language in his descriptions of the approach to be taken to nature, couched in terms of mastery over women and many with a sexual connotation, were provided by Merchant (1980, p.164-76). Philosopher Mary Midgley (1992) added the terms 'penetrated', pierced', vanquished', noting that these were the "common, constant idiom of the age" (p.77). She assured readers that this "outbreak of bizarre sexual metaphors in writings about science" was "quite real and not an invention of modern feminists" (Midgley 1992, p.88-9). Apart from the gender aspect, Midgley (1992, p.79) also drew attention to the imagery of violence that was evolving, one that leant itself to the later destructive approach that was adopted towards nature, particularly evident in the extraction of natural resources.

Just as Bacon's class and gender views crept into his scientific philosophy so too, it appears, did a third social value: capitalism. Both Leiss and Merchant related the rise of mechanistic philosophy to the emerging market economy, not necessarily as a product of the latter but as a philosophy that meshed nicely with it. Leiss (1994) noted Bacon's "passionate concern with material progress", and that "he constantly reiterated the point that his reformation in natural philosophy was intended to 'increase and multiply the revenues and possessions of man'" (p.51). Merchant (1980) stated that this increase in revenue as a result of the manipulation of nature increasingly "benefited those persons and social classes in control of its development, rather than promoting universal progress for all" (p.111), as the market economy "tended to widen the gap between upper and lower social classes" (p.80). In short, capitalist market economics and mechanistic science emerged together and merged into a symbiotic relationship. Leiss concluded that:

> . . . the victory of capitalist social relations over older institutional forms of economic life, first in Europe and then elsewhere on the globe, also cemented the triumph of modern science over competing systems of natural philosophy.
>
> Leiss 1994, p.xviii.

There is one further aspect of the mechanistic school of thought that can be seen to have implications for today's pesticide policy, one that further reveals the underlying value systems of the philosophy. That was the search for order and certainty through

[15] Translation from Latin of Bacon's work *The Masculine Birth of Time, Or The Great Instauration of the Dominion Of Man Over the Universe*, thought to have been written in 1603, and first printed in 1653 by Gruter (Farrington 1964, p.57).

science. Because it was believed that nature obeyed the same principles as a machine, was made up of discrete units of matter, of dead inert particles moved by external forces, a solution was at hand to the problem of intellectual uncertainty created, in part, by the anarchy of ideas fostered during the Reformation in Europe and by the sceptics of the late sixteenth century, according to Merchant (1980, p.194). The French philosophers Marin Mersenni, Pierre Gassendi and Rene Descartes all pursued the path of a mechanical philosophy of nature. For Descartes, the answer to uncertainty lay in mathematics, and his work led to the development of the quantitative approach to science—an approach that is increasingly being used today to 'overcome' the uncertainties inherent in toxicological data. Mathematical formalism still today provides the criterion for scientific rationality and certainty. The more a science can be reduced to mechanistic mathematical models of linear functions, the more objective and value-free it is considered to be. As noted already in Chapter 4, Gori (1996) believed the vagaries of nature can be subdued by the use of probabilities.

But in pursuit of the answer to uncertainty, these French mechanists, like Bacon, failed to mark out a value-free path for science, for they used their mechanistic philosophy to criticise social disorder, anarchy, individualism, uncontrolled passion and spontaneity, and individual criteria for religious truths. They elevated in their place "self-control, temperance, reasonable judgement and sovereign law" (Merchant 1980, p.195). In this manner social order and societal values were, as they had long been, inextricably mixed in with the pursuit of scientific knowledge. Order came to mean "the predictable behaviour of each part within a rationally determined system of laws", according to Merchant (1996, p.85). The redefining of reality through this metaphor of mechanism therefore provided for 'rational' control over both nature and society as a whole. Mechanism, as an underlying philosophy of science leading to logic, order and predictability, was thus also a particular worldview, a method of constructing social and intellectual order and for exercising power, in a Baconian sense over nature but, by extrapolation, over other elements of society through technology and capitalist economic patterns (Merchant 1980, p.217-8).

5.1.2 Mechanism as a worldview

Thus it has been demonstrated that the mechanistic philosophy not only gave rise to a set of rules for the pursuit of scientific knowledge, but also incorporated a raft of social, political and religious value systems into a particular worldview. Although there were many other worldviews to chose from, including Aristolelianism, Stoicism, Gnosticism, Hermeticism, naturalism, animalism, organicism, vitalism, and holism, it was

mechanism that became the dominant worldview in Western societies and with it the belief in the 'rightness' of controlling, dominating and exploiting nature. The mechanistic worldview enabled the justification of the exploitation of the environment for the sole benefit of a sub-section of humanity. Out of mechanism arose "homocentric management" of the ecosystem (Merchant 1980, p.252), driven initially by the 17th century need to ensure continued supplies of oak for the building of naval vessels in England and Europe. It allowed "rational management of nature through predictability and efficient use" (Merchant 1980, p.235), paying no heed to any purpose of nature other than to provide for humans. In so doing it radically changed the goals of science from those of the ancients, these being wisdom, the understanding of the natural order and living in harmony with it, to the single-minded pursuit of the control of nature, according to Merchant (1980). It is the mechanistic worldview, and particularly the ethics of exploitation of nature, that still underlie the value basis of science and science-based policy today:

> By the 19th century, the Western theme of mankind's power to control the forces of nature had acquired such cultural prominence that technological applications were widely celebrated and theories of risk became justifications for the profits of the successful entrepreneur.
>
> Dake 1992, p.22.

Critical theorists of the Frankfurt School, such as Max Horkheimer, Theodor Adorno, Herbert Marcuse and later Jürgen Habermas, have contributed significantly to the debate not only about the role of modern science in the domination of nature, but also to the worldview that it supports.[16] They drew attention to the relationships between modern science and capitalism, and between the domination of non-human nature through science and the domination of humans, especially social minorities, the labourer, and women. Social ecologists make the links between the domination of nature and the domination of humans (e.g. Bookchin 1981; Ecology Action East 1973). Ecofeminists link the domination of nature with that of women (e.g. d'Eaubonne 1974), and the environmental justice movement links it with the domination of indigenous and Third World peoples (e.g. Shiva 1989). It is acknowledged that the development of science and capitalism is inextricably linked, as is the domination of human and non-human nature. However, the intention here is to concentrate on two of critical theory's central concerns, the "triumph of instrumental reason and the domination of nature" (Eckersley 1992, p.99), whilst holding at the periphery of the discussion an awareness of

[16] The Frankfurt school (officially the Frankfurt Institute of Social Research) was an independent institute founded in 1923 for the purpose of exploring social phenomena (Eckersley 1992, p.214 endnote 1). Jürgen Habermas took over the chair in philosophy at Frankfurt from Horkheimer in 1964.

its relationship to other social issues—for it is these two issues that are central to the problematic of pesticide policy by the method of toxicology.

According to Merchant (1996), Max Horkheimer and Theodor Adorno drew attention to the way in which instrumental reason, and particularly mathematics, had become so deeply imbedded into mainstream society that it came to be presumed to be reality, to be synonymous with truth, all other modes of participating in the world being banished to the "periphery of society" (p.4). Horkheimer and Adorno (1944) were fairly ruthless in their critique of modern science: "what men want to learn from nature is how to use it in order wholly to dominate it and other men" (p.44). Mathematical procedure became "the ritual for thinking" (p.44). Nature was to be understood only in terms of mathematics and that which would not fit "is converted by means of mathematical theorems" (p.49). Nowhere is this truer than in the toxicology of pesticides, as has been demonstrated in Chapter 4. It is the concept espoused by positivists such as Gori (1996), displayed by his belief in the ability of probabilities to provide 'virtual verification' of nature.

The critical theorists argued that instrumental rationality should not be the model of rationality that guides society.[17] Of particular relevance to this thesis is Habermas's view that, because science can only understand nature in an instrumental sense, the 'scientization' of political decision-making has reduced the latter to pragmatic instrumentality, resulting in the lay public ceding more and more of their democratic rights to the technocratic elite (Eckersley 1992, p.98). Other theorists, such as Marcuse, argued the need for a new science, one that might overcome some of the limitations of instrumental rationality, according to Robin Eckersley (1992, p.104-5).[18] The matter of concern here, however, is not so much the need for a new science, but rather the need for a new policy-making process in which the scientific rationality is more evenly balanced with social rationality, one in which technological rationality does not banish ecological rationality. The role of knowledge systems and democracy in that new policy process will be discussed in Chapters 6 and 7. The topic of this chapter is that of ecological rationality as contrasted with technological rationality or mechanism.

Before embarking on an analysis of ecological rationality and its promise for pesticide policy, a note of explanation must be provided regarding the apparent reductionism displayed by the preceding assessment of the role of values in the development of

[17] Instrumental rationality is defined by Eckersley as "the branch of human reason that is concerned with determining the most efficient means of realizing pregiven goals and which accordingly apprehends only the instrumental (i.e. use) value of phenomena" (1992, p.98).

[18] Eckersley, Australian Research Council Fellow, Centre for Environmental Studies, University of Tasmania.

science, and the consequent effects on the value systems, and hence assessments, of scientists. It is not the intention to portray all scientists as being gender biased, socially elitist or 'anti-environment'. Rather, the intention is to provide an understanding of how deeply values are embedded in the pesticide policy process as a result of its virtually exclusive dependence on toxicological assessment and scientific/technological rationality.

5.2 Ecological rationality

It has been demonstrated that modern mechanistic science in general, and that which applies to the use of pesticides in particular, can be characterised by a particular worldview, generally referred to as the domination of nature. Secreted within that worldview lie hidden elements of social biases. The analysis of social rationality in Chapter 2 drew attention to a number of factors that affect assessment of risk by members of the public. In the process it identified an important cultural difference between the technical experts, in particular toxicologists, and members of the public. That difference can be generalized in terms of technological and ecological orientations, according to Bernd Rohrmann (1996, p.7).[19] As a generalization, and acknowledging the reductionist nature of this approach, a number of surveys have indicated that toxicologists have a greater degree of technological enthusiasm as an underlying value system than do the public. Conversely, the surveys showed that the public exhibits a greater tendency towards egalitarianism than do the toxicologists. Whilst this cannot be applied as a hard and fast rule, nevertheless it does indicate an important conceptual difference—for egalitarians tend towards a more ecological orientation as an underlying value system, according to Karl Dake (1992, p.30).[20] Technological orientation, derived from the domination principle, can be characterised by an instrumental valuation approach towards nature, whereas an ecological orientation can be broadly characterised by an intrinsic valuation approach. Intrinsic valuation will be discussed at greater length later in this chapter.

At the heart of the instrumental utilitarian approach of mechanistic science towards nature, and specifically its domination, lies anthropocentrism—the elevation of human interests above those of nature for the reputed betterment of humanity. It should be made clear that anthropocentrism was not invented by the mechanistic sciences. In fact,

[19] Professor Rohrmann, School of Behavioural Sciences, University of Melbourne, Victoria, Australia.
[20] Dake, University of California, Berkeley.

it appears to date back to Socrates. George Sessions (1991, p.141-2) credited Bertrand Russell with observing the 'undue' emphasis placed by Socrates on humanity in relationship to the rest of the universe.[21] Aristotle cemented anthropocentrism as the dominant paradigm with his philosophy that humans are superior to all other elements of the ecosystem because of their superior rationality, and that "nature made plants for the use of animals, and animals were made for the sake of humans" (Sessions 1991, p.142), a belief that also found currency in the Judeo-Christian religion.

The anthropocentric paradigm is widely assumed to represent the view of western society as a whole. But it is challenged by those who propose that an ecocentric approach is more ethical. This challenge is not new. Anthropocentrism has been opposed throughout the centuries since it first gained currency, and long before the 17th century developments of mechanistic science cemented it into the dominant paradigm for modern society. The first apparent major opposition to it came from Saint Francis of Assisi in the thirteenth century, according to Sessions (1991, p.142).[22] Saint Francis challenged Christianity's belief in the superiority of humans over nature. The second major challenge acknowledged by Sessions was that of the Dutch philosopher Baruch Spinoza who, in the seventeenth century, proposed a non-anthropocentric philosophical system, at the same time that the mechanistic school was cementing anthropocentrism into modern science. Since then many erudite philosophers have taken up Spinoza's challenge to science, and its underlying Greek and Judeo-Christian traditions, by proposing more respectful approaches to nature—philosophers and writers such as Bertrand Russell, Arne Naess, George Santayana, Walt Whitman, D.H. Lawrence, Aldous Huxley, Aldo Leopold, Rachel Carson, Roderick Nash, Holmes Rolston III, J Baird Callicott, and many others.

The call for a paradigm shift with respect to nature has been gathering momentum throughout the twentieth century, and exerting increasing effect on modern science, to the extent that some ecological values are recognised in many branches of science. The damage that has been caused to the ecosystem, by the application of mechanistic science coupled with anthropocentrism, is increasingly acknowledged. Nearly twenty years ago the United Nations introduced that new paradigm into an international document for the first time, according to Prue Taylor (1998a, p.328).[23] The document was the 1982 World Charter for Nature:

[21] Pre-Socratic philosophy is described by Sessions (1991, p.142) as being heliocentric.
[22] Sessions referred to historian Lynn White's classical paper, which appeared originally as: White L, Jnr. 1967. The historical roots of our ecological crisis. *Science* 155:1203-7.
[23] Prue Taylor, Senior Lecturer in Law, University of Auckland.

> Its preamble expresses some distinctly eco-centric thinking, referring to mankind as *part of nature*, to civilization as rooted in nature, to every form of life as being unique and *meriting respect regardless of its worth to man*, and the need for man to be guided by a code of moral action.
>
> P Taylor 1998a, p.328.[24]

In the intervening years there has been further tentative inclusion of some ecocentric concepts in international treaties and domestic law (P Taylor 1998a, p.328-9). Paralleling that has been the ongoing development of the Earth Charter, a Charter which was initially developed for the 1992 Earth Summit, but which failed to achieve inter-governmental agreement. Instead, the Earth Summit adopted the Rio Declaration on Environment and Development, which included "principles central to the achievement of sustainable development, but . . . makes only very weak reference to environmental ethics" (P Taylor 1999a, p.194).

Now, at the beginning of a new millennium, there comes the possibility of that paradigm shift to an ecocentric approach, according to Klaus Bosselmann (1995, p.21).[25] This view was also advanced by J Baird Callicott (1994, p.12), although he referred to an 'environmental' rather than an 'ecocentric' approach.[26] Certainly such a position is supported by the rise in power of the Green Party in New Zealand, with just over 5 percent of the national vote in the 1999 general elections, that figure rising to 12 percent in the largest urban area, Auckland City.[27] It is also supported by the gathering literature on the subject of ecological rights in international law (e.g. Bosselmann 1995; Boyle & Anderson 1996; P Taylor 1998a, 1998b). The development of the Earth Charter is continuing, conducted by a global organization of citizens with extensive global consultation occurring, that consultation intended in part to facilitate the change in attitudes, values and behaviour that are necessary to implement a global ethic of

[24] Taylor cited *General Assembly Resolution on a World Charter for Nature*, G.A. Res. 37/7, U.N. GAOR, U.N. Doc. A/RES/37/7 (1983).

[25] Bosselmann, Associate Professor, New Zealand Centre for Environmental Law, University of Auckland.

[26] Callicott (1994) also referred to the emergence of an *organic* worldview replacing the *mechanistic* one (p.5,199). Norton (1991), too, referred to organicism, firstly with respect to Leopold's Land Ethic (p.54), but then also as a systems approach to ecological reality (p.154,253). The organicism terminology is omitted as a descriptor of an environmental ethic here purely because of potential confusion at this stage with its much narrower usage in the form of organic agricultural systems, although the latter do in fact derive from the broader organismic environmental ethic. Organic agriculture, as an application of an ecocentric ethic, will be discussed later in this chapter.

[27] Prue Taylor (1998b, p.59 note 253) reported that in 1990 approximately 10 million Americans were members of environmental organisations. Source: The Economist, 1990 Apr 21. London. p 35.

sustainability (P Taylor 1999b, p.22-3).[28] The first principle of the Charter, under the heading of "Respect Earth and life in all its diversity", is to "recognize that all beings are interdependent and every form of life has value regardless of its worth to human beings" (Earth Charter Campaign 2000). Prue Taylor (1999b, p.23) reported that this principle is very similar to that contained in the International Union for the Conservation of Nature (IUCN) draft International Covenant on Environment and Development:

> Respect all life forms. Nature as a whole warrants respect; every form of life is unique and is to be safeguarded independent of its value to humanity.
>
> IUCN 1995, cited in Taylor 1999b, p.24.[29]

Therefore the ecocentric approach, as an emerging consciousness, a worldview of gathering momentum that stands in stark contrast to the mechanistic philosophy of toxicology, deserves further scrutiny for the purposes of pesticide policy development. For Sessions (1991) described anthropocentrism as a "detour" that humanity had embarked upon, noting that "the vast majority of humans who have lived on earth over the millennia have been hunters/gatherers, [and] it is clear that *ecocentrism* has been the dominant human religious/philosophical perspective through time" [emphasis added] (p.140). It was agriculture that created that detour, with its 'taming' of nature, commoditization of resources, and eventual delineation of nature as private property. The history of environmental problems began with agriculture, with water deficits and erosion dating back to the Sumerian and Babylonian cultures at least, according to Bosselmann (1995, p.53).[30] But it is the use of pesticides in agriculture, and now also the genetic manipulation of plants and animals to satisfy purely human wants, that represents the apex of human endeavour to dominate the agro-ecosystem, the ultimate in anthropocentrism. Agriculture and its use of pesticides, in this instance, is therefore at the forefront of modern societal systems for which close study of the ecocentric ethic is required, for at the apex of that domination the ecosystem-destroying nature of humanity's system of sustenance has become apparent. Pesticides now contaminate soil,

[28] A final version of the Earth Charter was issued by the Earth Charter Commission after their March 12-14, 2000 meeting at the UNESCO headquarters in Paris. However, the Commission plans to review responses to the document over the next two years and consider possible amendments.

[29] The IUCN Draft Covenant was created over a six year period and emerged in 1995 as a basis for future intergovernmental negotiations on a treaty requiring all states to protect the whole of Earth's environment (P Taylor 1998b, p.175).

[30] Dr Fred Kirschenmann (1999, p.280) referred to the work of WC Lowdermilk (1953) of the US Department of Agriculture's Soil Conservation Services, who asserted that soil erosion, overgrazing and deforestation had contributed to the wiping out of entire civilizations over 7,000 years. Lowdermilk also "found fields that had been farmed for thousands of years without soil or environmental deterioration" (Kirschenmann 1999, p.280).

water and air throughout the planet.[31] They are found in polar snow, in fog and rain.[32] They are found in the body tissues of wild animals and humans, and the bark of trees, worldwide.[33] They are implicated in mass die-offs of marine mammals, and population crashes of birds, amphibians and alligators.[34] Some of them, such as the halogenated compound methyl bromide, contribute to destruction of the ozone layer (UNEP 1992). Increasing recognition of the interconnectedness of escalating environmental problems such as these (P Taylor 1998b, p.28) is influencing society's serious reconsideration of the wisdom of the anthropocentric ethic. It has been widely assumed, without rational review of the evidence to the contrary, that humanity's existence depends on the ecosystem-destroying approach to nature that characterizes modern chemical-based agriculture. However, with the tide beginning to turn in favour of an ecocentric ethic, there comes an increasing criticism of this assumption and increasing interest in the more ecocentric approach of organic agriculture which will be briefly described later in this chapter.

5.2.1 Ecocentrism, an ecological ethic

There is no one consistent ecological ethic that stands against the domination of nature ethic, but rather a whole raft of different positions that are the worldview of different indigenous cultures, various environmental organizations, ecofeminists, deep ecologists, philosophers and many others.[35] There are two constant threads that run through these positions. The first of these is the valuation of ecological entities for their own sake rather than as resources for human exploitation. The second thread is the concept of

[31] For residues in soil see, for example, Szeto & Price 1991; Thao, Kawano & Tatsukawa 1993; Kookana, Baskaran & Naidu 1998; MfE 1998. For residues in New Zealand groundwater see, for example, Smith 1993; in US groundwater see Ritter 1990; in UK groundwater see Clarke, Gomme & Hennings 1991; in Canadian rivers see Frank, Logan & Clegg 1991; in seawater see Sauer, Durell, Brown, Redford & Boehm 1989. For residues in the air see, for example, Bidleman, Patton, Walla, Hargrave, Vass, Erickson, Fowler, Scott & Gregor 1989; Larsson & Okla 1989; Greenpeace 1992; Aston & Seiber 1997.

[32] For residues in snow see, for example, Gregor & Gummer 1989; Welch, Muir, Billeck, Lockhart, Brunskill, Kling, Olson & Lemoine 1991. For pesticides in fog see Glotfelty, Seiber & Liljedahl 1987; Rice & Chernyak 1997. For a review of pesticides in rain see Kirknel 1992; also Trevisan, Montepiani, Ragozza, Bartoletti, Ioannilli & Del Re 1993; Doerfler & Scheunert 1997; Nohara, Hanazato & Iwakuma 1997.

[33] For residues in animals see, for example, Brewerton 1969; Mason & Reynolds 1988; Hutchinson & Simmonds 1991; Colborn & Smolen 1996; Ayas, Barlas & Kolankaya 1997; Reid 1999. For residues in human breast milk see, for example, Bates, Buckland, Hannah, Taucher & van Maanen 1990; Spicer & Kereu 1993; in follicular fluid see Trapp, Baukloh, Bhnet & Heeschen 1984; in urine see Kutz, Cook, Carter-Pokras, Brody & Murphy 1992; in adipose tissue see Skaare, Tuveng & Sande 1988. For residues in the bark of trees see Simonich & Hites 1995.

[34] See, for example, Johnston & McCrea 1992; Newton & Wyllie 1992; Woodward, Percival, Jennings & Moore 1993; Colborn *et al.* 1996; Graf 1999.

[35] Such as autopoietic theory, ecofeminism, deep ecology, transpersonal ecology, animal liberation, Gaia Theory, Aldo Leopold's 'land ethic', biocentrism.

unity as opposed to Cartesian dualism, i.e. the oneness, the unity of all living organisms, rather than the separation of human from non-human nature, subject from object, mind from matter, logic from intuition, science from spirituality, that permeates modern science and with it the modern approach to policy development. These two threads form the basis of ecocentrism.

Ecocentrism pivots on the understanding of reality in a non-dualistic manner, as a relationship between humans and non-human nature (Bosselmann 1995, p.149). It is in the context of that relationship that valuation of all nature in its own right becomes understandable. Just as the anthropocentric ethic places humanity at the centre of all things, so an ecocentric ethic places the ecosystem or nature at the centre of all things. This is a crucial concept, for herein lies the basis of much of the criticism of ecocentric ethics. This criticism wrongly assumes that it is only non-human nature that is placed at the centre of all things, with humanity cast to the edges, or absorbed into sameness with nature, thus being an anti-human ethic (Eckersley 1992, p.56). Rather, an ecocentric ethic places humanity together with non-human nature at the centre, a concept that becomes self-evident once the non-dualistic relationship between humans and non-humans is understood. In this relationship both humans and non-human nature possess intrinsic interests, values and rights. Merchant (1996) expressed that relationship in terms of a partnership, Fritjof Capra (1996) as a web, and Arne Naess (1972) as a "biospherical net or field of intrinsic relations" (p.120).[36] Ecocentricism asserts that all things in nature have an intrinsic value in and of themselves, not just an instrumental or utilitarian value for humans. In terms of the 'good of society', the concept of Jeremy Bentham and John Stuart Mill, the meaning of society is expanded to include nature. Ecocentricism recognises the rights of other species to continue to exist. Thus, an ecocentric ethic simply adds the moral consideration of non-human nature to the raft of moral considerations that already guide and direct human endeavour. In so doing it displaces the concept of "human chauvinism" (Eckersley 1992, p.56) with respect for all life, and economic ascendancy (P Taylor 1999b, p.16) with ecological rationality.[37] Humanity is

[36] Capra, Director of the Centre for Ecoliteracy, Berkeley, California.

[37] The term ecological rationality is not used in this document in the narrow sense initially bestowed on it as that of "the capacity of a system to maintain or increase the life supporting capability of ecosystems consistently" (Plumwood 1998, p.561), the view of ecological modernism that relates rationality to particular functional aspects of the ecosystem, such as substance cycles and energy use (Spaargaren, Mol & Buttel 2000, p.6). In the same vein Bartlett (1986, p.91) referred to the following declaration in the USA's National Environmental Policy Act 1969, section 101, as ecological rationality: "to create and maintain conditions under which man and nature can exist in productive harmony". Rather, ecological rationality is used here in a much broader sense as a recognition of humanity's dependence on the environment, the environment's vulnerability to the effects of human behaviour, the interconnectedness of all aspects of the environment, and that rational decision-making is rooted in an understanding of this.

just as entitled to "live and blossom" as any other species, and to the extent that this requires killing other species or damaging ecosystems, ecocentrism seeks to minimize the harm and to maximize the opportunities for other species to similarly flourish (Eckersley 1992, p.57).[38]

It is not the intention to analyse all the variations on the theme of ecological orientation, for there are already many writings on the subject (e.g. Dobson 1990; Norton 1991; Eckersley 1992; Callicott 1994; P Taylor 1998b, p.26-48; Connelly & Smith 1999).[39] Rather, it is the intention to apply the two common threads of thought that differentiate the ecocentric, holistic approach from the mechanistic, domination rationale that underlies pesticide risk assessment, to the pesticide policy process. However, before these concepts can be applied to policy, they first must be understood, especially in relationship to the current predominant paradigm. They are therefore analysed here in the context of a comparison with modern science, and with pesticide policy. The first of the two themes is the ecocentric concepts of interdependence and monism, in comparison with mechanistic independence and Cartesian dualism. The second theme is that of respect for the intrinsic values of nature, in contrast to the characterizing of nature as a resource for human use.[40]

Interdependence versus independence, or the web versus the particle

The origins of the ecocentric ethic lie shrouded in the mists of time, long before the development of anthropocentrism, but its modern re-emergence can perhaps be

[38] Both Eckersley (1992) and Prue Taylor (1998b) provided succinct analyses, and rejections of, the other main criticisms of an ecocentric ethic. The first criticism, that humans cannot perceive the world in any way other than through an anthropocentric perspective ('impossibility') is rejected because it confuses the value of what is perceived with the identity of the perceiver. An ecocentric ethic does not demand that humans know what it is like to be nonhuman nature, but simply that humans develop a non-segregative, non-hierarchical attitude towards nature. A second criticism, that ecocentrism ignores the needs of the poor or socially oppressed ('misanthropy') is rejected on the grounds that emancipation for all nature, the basis of ecocentrism, necessarily supports social justice in the human community (Eckersley 1992, p.56). A third criticism, that ecocentrism idealizes nature, regarding it as benign and kindly, is a misconception, for ecocentrism does not impose human standards on nonhuman nature, but simply acknowledges its existence and its right to existence independent of human valuation. Lastly, a favoured criticism is that an ecocentric ethic is impractical and cannot be interpreted in law and policy. This criticism will be specifically addressed later in this chapter with the discussion of pesticide policy based on an ecocentric ethic.

[39] In 1995 Klaus Bosslemann (p.324) estimated about 6,000 publications in English alone on the subject of ecological ethics, with smaller numbers in the German and French languages.

[40] These two themes are reflected in the two principles of ecological justice proposed by Nicholas Low and Brendan Gleeson (1998): the first principle is that "every natural entity is entitled to enjoy the fullness of its own life" (p.156), and the second is that "all life forms are mutually dependent and dependent on non-life forms".

attributed, at least in part, to the work of Alfred Whitehead (1861-1947) (Bosselmann 1995, p.152). Whitehead encapsulated nature as an organic whole in which no objects exist in isolation. The re-emergence of this philosophy provided a direct challenge to the reductionistic nature of mechanistic science, as did that of the concept of 'holism', subsequently proposed by JC Smuts in 1926, in his book *Holism and Evolution*. Where mechanism sought to reduce living systems to individual parts, holism emphasised the interconnectedness of all things, with each part "defined by and dependent on the total context" (Merchant 1996, p.88). Where mechanism sort precision in mathematical linearity, holism emphasised the idea of cyclical processes, with the cycle being a "dynamic and interactive relationship of all its parts" (Merchant 1996, p.88).

James Lovelock's Gaia hypothesis emerged in the early 1970's as a direct challenge to science's dominating paradigm of mechanism—that is that all parts of the universe behave according to mechanical rules and that nature is no more and no less than a sum of its constituent parts, a machine that can be controlled and driven by external forces, and the whole of which can be known by studying the disconnected parts.[41] The Gaia hypothesis recast nature in a different light altogether, that of the planet Earth as a living organism. The hypothesis proposed that all living things on Earth together constituted a whole, a single entity, but in this case a living entity that, as such, had faculties greater than the sum of its constituent parts. The naming of the hypothesis was an innovation, but the concept was not entirely new, for it reflected the pre-mechanistic schools of thought dating back to the times of Aristotle, and referred to collectively by Merchant (1996, p.76-7) as 'organisicism', in which nature was seen as a living being.

Ecological philosophy moved beyond the mere interrelatedness of non-human species with each other and with the environment within which they live, in particular extending these relationships with humans. Naess's deep ecology and Warwick Fox's (1990) transpersonal ecology both expounded upon the relationship between self and nature (Connelly & Smith 1999, p.17). Both were concerned with transformation at the personal and social level. A wider sense of self is sought through the process of identification with nonhuman nature (Eckersley 1992, p.61). This approach assists in creating an understanding of the relationship between human and nonhuman nature, an understanding that is vital to achieving the change in attitudes and thinking that must precede the behavioural changes necessary to implementing an ecocentric ethic. The

[41] Merchant (1996, p.4) referred to Lovelock's papers "Gaia as seen through the atmosphere " (1972), and "Gaia hypothesis" (1973); and to his popular book *Gaia: a New Look at Life on Earth*.

topic will be raised again later in this chapter during the discussion on interpreting the concept of intrinsic value into policy.

Whilst ecological philosophy was delving further into the meaning and consequences of the interrelatedness of humanity and nature, similar challenges to mechanistic philosophy were taking place within specific branches of scientific endeavour. These are of relevance to the development of pesticide policy specifically because of the challenge they provide to modern toxicology, and in particular ecotoxicology. Therefore, a brief review of some of the more relevant aspects is provided below.

Physics

Although there were many natural philosophers who understood the notion of the interconnectedness of nature, physics was the scientific discipline that made the early progress in dispelling the mindset of mechanism within science itself. Physicist David Bohm (1988) provided a neat summary of that progress, and in the process extended it into a postmodernist theory of 'unbroken wholeness'. In the following section, Bohm's analysis of the nature of physics is extended to ecotoxicology, a primary methodology of pesticide policy.

According to Bohm (1998), by the end of the nineteenth century the Newtonian mechanistic view of physics was established as "certain and complete" (p.345). Physics was understood in the modern scientific paradigm of a world reduced to a basic set of elements, in which all matter consisted of discrete particles and, by extension, all biological systems consisted of discrete separate parts.[42] Additionally, these discrete elements, and discrete parts, were external to each other, i.e. were fundamentally independent of each other and had their own independent nature. In a biological sense, these parts could be independently manipulated to achieve the required result, and this is the basic methodology of modern agriculture.[43] In terms of ecotoxicology, it means that the ecological effect of pesticides can be known by assessing the effect of a pesticide on discrete separate parts of the ecosystem.

However, the mechanistic approach to physics was challenged, first by Einstein's theory of relativity, and then more completely by the theory of quantum physics. In the former, the notion of discrete separate particles of matter gave way to "a field spread through all

[42] These particles were known first as monads in Baconian science (Shapin 1996), then as atoms, then became broken down to electrons, protons, and neutrons, and now to quarks, possibly with some type of subquarks to follow (Bohm 1988, p.344).
[43] It is also the basic methodology of genetic engineering (Bohm 1988, p.344).

space, which would have strong and weak regions" (Bohm 1988, p.345). Particles as such were no longer seen to exist. Instead, a particle was understood as "a certain form in a field of movement" (Bohm 1988, p.346). Bringing two particles together resulted in the modification of each of them until they eventually became one. From this developed the notion of what Bohm referred to as "unbroken wholeness or flowing wholeness" (Bohm 1988, p.346). Despite this, the theory of relativity still retained the mechanistic notions of separate existence, in this case of the fields at different points in space giving rise to the notion of "locality" (Bohm 1988, p.346). Locality means that there is no long-distance connection between these fields, no long distance connection between separate elements of nature.

The concept of unbroken wholeness also characterised quantum physics according to Bohm (1988, p.348). However, there are a number of essential differences between this latter development and both the earlier theories of mechanism and relativity. Bohm summarized these as follows (1988, p.346-7):

- All motion consists of discrete indivisible units called quanta. This contradicts the mechanistic notion of continuous motion of particles.

- Matter and energy may be manifested like a wave or like a particle, their exact behaviour depending on the context in which they are treated. "The quality of the thing depends on its context" (Bohm 1998, p.347). In mechanism, the particle is the same regardless of context.

- In certain areas, things could apparently be connected with other things any distance away without any apparent force to carry the connections. This idea of nonlocality, which opposes both mechanism and Einstein's 'locality', finds resonance with the mathematical theory of chaos, as will be briefly discussed below.

- Lastly, in complete contrast to mechanism, quantum physics found that there is an internal relationship between all parts of a whole and between each part and the whole. Indeed it is the whole that organizes the parts.

Fritjof Capra summarized this radical reversal of mechanistic thought resulting from quantum physics thus:

> In the 1920s, however, quantum theory forced them [physicists] to accept the fact that the solid material objects of classical physics dissolve at subatomic level into wave-like patterns of probabilities. These patterns, moreover, do not represent probabilities of things, but

> rather probabilities of interconnections. The subatomic particles have no meaning as isolated entities but can be understood only as interconnections, or correlations, between various processes of observation and measurement. In other words, subatomic particles are not 'things' but interconnections between things, and these, in turn, are interconnections between other things, and so on. In quantum theory we never end up with 'things'; we always deal with interconnections.
>
> Capra 1996, p.30.

The probabilities of interconnections are determined by the dynamics of the whole system. Again, the whole determines the part, in stark contrast to the basic tenet of mechanism that it is the sum of the parts that determines the whole. Geoffrey Chew's bootstrap theory of particles followed a similar line of reasoning. Capra described this theory as follows:

> Physical reality is seen as a dynamic web of interrelated events. Things exist in nature by virtue of their mutually consistent relationships, and all of physics has to follow uniquely from the requirement that its components be consistent with one another and with themselves.
>
> Capra 1988, p.337.

To conclude then, quantum physics was characterized by Bohm in this manner: "all of that adds up to the notion that the world is one unbroken whole" (Bohm 1988, p.347). This concept, now well established in physics, is the concept that underlies the interdependence of nature in the ecological worldview. Whilst the brief summary provided here does not do justice to the intricacies of quantum theory, it does serve to accurately portray that aspect of the theory that is of relevance to pesticide policy—namely that mechanical reductionism as a scientific philosophy has been superseded by the notion that all parts of nature are interrelated.

Ecology, environmental science and ecotoxicology

Echoing the advances of thinking in the realm of physics, biological sciences developed, to a lesser degree, along similar lines with the advent of ecology. The term ecology was coined by German biologist Ernst Haeckel in 1866, according to Capra (1996, p.33), and was defined as "'the science of relations between the organism and the surrounding outer world'" (Haeckel, as cited in Capra 1996, p.33).[44] Throughout succeeding years,

[44] Capra cited the source of the Haeckel quote as Maren-Grisebach M. 1982. *Philosophie der Grünen*. Munich: Olzog.

the science of ecology continued to develop, focussing on functional relationships within plant and animal communities, and emphasising the essential role of every part of an ecosystem.[45] Lovelock's concept of the planet Earth as a living organism was not adopted by modern biological sciences, but the broad concept of holism was, at least in terms of recognition of the importance of a functioning ecosystem, that being the community of organisms interlinking with each other and their physical environment as a unitary whole.

Environmental science, a more recent offshoot of ecology, also recognizes the interconnectedness of nature, at least in theory. Professor John Hay (1998a) acknowledged "the complex, non-linear interactions characteristic of integrated environmental systems" in his preface to the proceedings of a workshop on risk assessment of environmental end points (p.i).[46] In the same document, Hay (1998b, p.19) referred to environmental systems as dynamic, rarely exhibiting stability, typically non-linear and sometimes exhibiting chaotic behaviour. His comments were based on the work of Wayne Landis and colleagues (Landis 1998; Landis, Moore & Norton 1998, cited in Hay 1998b), who rejected the previously held notion of natural ecosystems as being stable and balanced, a point that will be seen to have significance in the following discussion of the intrinsic value of nature and how this concept has been interpreted by New Zealand law.

Landis (1988) referred, also, to the "extreme persistence of information following a toxic insult" (p.24) to an ecosystem, that information residing in a number of parameters, ranging from the genetic heterogeneity of mitochondrial DNA to population dynamics, and persisting long after the toxicant has degraded. Landis stated that:

> . . . effects at the molecular and organismal level, such as toxicity, can have impacts upon metapopulation structure and landscape. There is a connection between molecular biology and the shape of the landscape.
>
> Landis 1998, p.27.

Landis (1998) concluded that the context in which an environmental stressor occurs is vital, for the same stressor can have very different impacts depending on its location in

[45] Modern ecology cannot be said to be based on an ecocentric ethic simply because it recognises the interconnection of various aspects of the ecosystem. Naess (1972) differentiated *ecology* as a practice of modern scientific methods from *ecosophy*, or ecological philosophy, a philosophy of ecological harmony or equilibrium. Later, sociologist Bill Devall (1980, p.131) charged that ecology as a science is open to co-option by the technological fixers of the shallow environment approach who want only to enhance the environment for humanity's use.

[46] Hay, Woodward-Clyde Professor of Environmental Science, University of Auckland.

the environment. He warned that "site specificity is critical in making predictions of potential outcomes" (p.27). Note the similarity of this statement to the quantum physics concept of the dependence of the behaviour of matter on the context within which it exists.

However, despite the apparent recognition within physics and more recently environmental science of the interconnectedness of nature, ecological risk assessment of pesticides is still rooted firmly in the reductionist approach, using isolated endpoints as indicators of environmental effect, with little regard for the site specificity suggested by Landis as being critical, or to wider ecological implications. Typically, such an assessment measures acute, and in some cases chronic toxicity, of a single chemical on a range of singular species, together with several environmental fate parameters, the latter taking the place of the exposure data required for human risk assessment. The ecotoxicology tests required for the pesticide registration system established by the Pesticides Act 1979 are:

- Birds, mammals and other vertebrates (wild):
  - Acute
  - Short term
  - Special studies (chronic, reproduction, simulated or field testing, etc)
- Aquatic organisms (freshwater and marine)
  - Acute
  - Short term
  - Special studies (chronic, early life-stage, simulated or field testing, etc)
- Non-target invertebrates (terrestrial)
  - Predators
  - Parasites
  - Bees
  - Earthworms
  - Soil micro-organisms
  - Other
- Non-target vegetation
  - Results from laboratory tests
  - Observations from field trials or efficacy tests.

ACVM Group 1998, p.41.

Proposals for ecotoxic criteria for registrations of pesticides under the HSNO Act reveal little change in the reductionist approach of compartmentalizing the environment. In these proposals thresholds have been suggested for establishing, for example, aquatic toxicity, as follows:

> Either the acute LC_{50} (96 hour) marine or freshwater fish; or
> the acute EC_{50} (48/96 hour) crustacea; or
> the EC_{50} (72/96 hour) algal growth inhibition, is $\leq$100mg/litre.
>
> OR
>
> EITHER one of the above acute effects AND
>
> The Bioconcentration factor (BCF) is $\geq$500; or
> if the BCF is not available, the log K_{ow} (partition coefficient) is $\geq$4.
>
> OR
>
> Where the substance is not readily biodegradable or the ratio of $BOD_{(5days)}$ to COD is <0.5 (that is, it is not readily biodegradable).
>
> MfE 1997a, p.2-3.[47]

Similar thresholds exist for other compartments of the environment, namely within-soil microrganisms, plants and invertebrates, and above-ground invertebrates and vertebrates. If toxicological tests reveal that the pesticide in question exhibits one or more effects above the threshold values, then it will be deemed to have an ecotoxic property. It will subsequently be classified as "very toxic", "toxic", or "harmful", depending on the extent of the effect (MfE 1997b, p.3). This classification, together with the risk for human health established using the methods described in Chapter 3, will then be weighted against the estimated benefits to be gained from using the pesticide, and a decision made whether or not to register it for use. If, on the other hand, the results of ecotoxicology tests show that the pesticide does not trigger the threshold levels such as those described above, then the pesticide is described as "non-ecotoxic" (MfE 1997b, p.5) and assumed to have no adverse effects on the environment at all.

In both systems described above, the criteria are applied to a single species at a time, with no recognition of the interconnections between them and the myriad other species, and stressors, in the environment. There is no recognition of the complexity and non-linearity of interactions referred to previously by Hay, or the extreme persistence described by Landis as effects ranging from changes in mitochondrial DNA to changes in metapopulations. It cannot incorporate the significance of *context* as found in quantum theory and as referred to by Landis. Certainly, it does not have the capacity to incorporate the enormous, unpredictable effects that can result from arbitrary tiny

[47] Terms not defined in the MfE document. Chambers Science and Technology Dictionary provided the following: LC_{50} = concentration required to kill 50% of test animals; BOD = biological oxygen demand; COD = chemical oxygen demand; EC_{50} = the environmental concentration required to kill 50% of tests populations.

influences as described by chaos theory. Chaos theory is based on the nonlinearity of phenomena and their consequent inherent unpredictability, or rather predictable unpredictability, classically illustrated by Edward Lorenz's butterfly effect: "a butterfly fluttering in Iowa could, in principle, trigger an avalanche of effects culminating in a monsoon in Indonesia" (Horgan 1996, p.192).[48] Landis's (1998, p.23) description of the historical nature of ecosystems, in terms of preservation of information about prior events that affect the dynamics and responses of the extant system, finds resonance with complexity theory's concept of 'self-organised criticality'. This concept is illustrated by Per Bak in the sandpile analogy.[49] Simply put, as grains of sand are added to a sand pile, the pile approaches a critical state "in which even a single additional grain of sand dropped on the top of the pile can trigger an avalanche down the pile's sides" (Horgan 1996, p.204). Such an analogy bears a close resemblance to the reports of many chemically sensitive people in which, for the person whose bodily system is already loaded with chemicals or depleted by the effects of chemicals, the addition of even a minute dose can trigger an avalanche of sensitivity symptoms. If this occurs with humans, there is no reason to assume that it does not also occur with other inhabitants of the ecosystem.[50] In the words of ecotoxicologist Paul Jepson:

> . . . we are still a long way from understanding the ways in which ecological processes and pollutant impacts interact . . .
>
> Jepson 1993, p.1549.[51]

It is contended that the complexity of the ecological situation within which a pesticide is used defies description by a mechanistic, compartmentalising approach. Thus, ecotoxicology fails to depict the true picture of ecological risk from multiple and ongoing pesticide use. The true ecological outcome of any spray event involves the topographical minutiae, microclimatic variations, and applicator behaviour that affect the movement and deposition of a pesticide, interacting with the constantly changing

[48] Lorenz, meteorologist at the Massachusetts Institute of Technology. This effect appears to derive from the principle of quantum mechanics known as 'nonlocal connection', in which "things could apparently be connected with other things any distance away without any apparent force to carry the connection" (Bohm 1988, p.347).

[49] Bak, a Danish physicist associated with the Santa Fe Institute which was labelled by Horgan (1996, p.132) as the 'headquarters' of the field of complexity. Also Brookhaven National Laboratory (p.206).

[50] This position is a logical extension of thinking. Scant evidence appears to exist to support it, perhaps because evidence has seldom, if ever, been sought. Neither, it is contended, is there substantial evidence to refute the position.

[51] Jepson, Ecotoxicology Research Group, School of Biological Sciences, Southampton University, UK.

nature of every individual organism in the ecosystem[52] in response to its environment, including interactions with each other and human-generated stressors such as industrial contaminants, chemical fertilizers, chlorinated and fluoridated water, ozone depletion and global warming. Add to this the implications of Landis's 'ecological history', and there would seem to be little basis for assuming that the results of the reductionist ecotoxicological deduction bear much resemblance to reality.

In conclusion, the ecological rationality of connectivity, of interdependence and holism, finds resonance with postmodern physical and mathematical theories, as well as with ecological theory.[53] It is contended, therefore, that the mechanistic approach of pesticide policy based on toxicology and ecotoxicology can no longer be regarded as rational, and that rationality lies instead with an ecocentric approach. Bohm noted that, although the dissolution of the mechanical view of nature occurred many years ago, at least from the view point of physics, many scientists in other disciplines, and no doubt even more public policy makers, have failed to grasp the implications of this. Hence, the mechanistic science approach continues to dominate in many areas (Bohm 1988, p.343).[54] This comment was made in 1988. It is quite possible that the postmodernist approach has been more widely adopted in the last decade, although its continued absence must be noted in the field of pesticide toxicology, and incidentally also in the field of genetic manipulations of biological material. To this day, the toxicological measure of the environmental effect of pesticides is the individual health end point for single chemicals on single species. It is not surprising, therefore, that when toxicology is presented with the problem of multiple chemical sensitivity in real people, it can do nothing but deny its validity, basing its rationale as it does on the reductionist model. It is not surprising, also, that multiple chemical sensitivity, as a potential environmental effect, is not contemplated at all. Quantum physics, ecology and biology have all demonstrated that humans and all other members of the ecosystem act and react to chemicals as whole beings, and as interconnected parts of an ecosystem, not as single organ systems in single species. Increasingly, biologists and ecologists understand life in terms of the concept of a web, of closely interdependent parts, of webs between communities of

[52] As a measure of the scale of things, Jepson (1993, p.1549) stated that over 400 species of invertebrate predators and parasites colonize cereal fields alone.

[53] Postmodernism lacks an established definition. It pivots about a search for values that cannot be defined currently, resting on ideas and principles that are purely constructed and therefore can be de-constructed—a central methodology. It challenges the 'triumph of the western civilization'. It challenges the assumptions of modernity of progress in knowledge, reason, technology and the economy (Garé 1995, p.4-5). It challenges "faith in the kind of scientific and scholarly knowledge that can come from reason alone" (Nisbet 1980, p.317, cited in Garé 1995, p.5). Reconstructive modernism is creative, rebuilding from the deconstructed foundations (Callicott 1994, p.185).

[54] Callicott (1994) included "economic reductionism" and "preference utilitarianism" here (p.185).

organisms and within communities of organisms (Capra 1996, p.35). Therefore, the effect of large-scale pesticide use on biodiversity is becoming more and more a concern as the systems thinking deepens (Stolton 1997).[55] Again, it is not surprising that toxicology is unable to assist here. Toxicology has failed to develop in line with 20th century scientific understanding of the nature of life. As a scientific and political discipline, it continues to go deeper into mechanism in search of the perfect mathematical model that will provide 'virtual reality' whilst steadfastly turning away from reality itself. To base pesticide policy on a risk assessment methodology that views one chemical at a time on one separate unit of nature, be it acute toxicity to a rat or chronic toxicity to a trout, is no longer supported by scientific philosophy, let alone ecological philosophy. The problem lies not in the finding of toxicity to a species, but rather in the denial of risk to the ecosystem in the absence of statistically significant evidence of single species toxicity. In an ecological sense, this is irrational.

Intrinsic versus utilitarian/instrumental versus inherent valuation

Whilst it is the failure to view nature as consisting of interconnected entities that lies at the heart of toxicology's difficulties, it is the second theme, that of the valuation of nature, which lies at the heart of pesticide policy, and which largely determines the shape of the final policy. Whereas the first theme demonstrates ecological rationality, the second adds an ethical dimension, although as Bosslemann (1995) pointed out, and as will be discussed later, the two themes, in fact, are closely interrelated.

Approaches to the valuation of nature are usually expressed as being either anthropocentric or ecocentric. Merchant (1996), however, subdivided anthropocentrism into *egocentrism* and *homocentrism*, and this sub-classification provides a useful basis for understanding valuation of the environment with regard to pesticides. The egocentric ethic she related to the Hobbesian philosophy of the individual's freedom to profit from the environment through resource depletion and pollution.[56] Nature is "conceptualized as a dead machine" (Merchant 1996, p.213), to be manipulated for profit. All environmental costs are externalised. It is contended that this is the ethic that underlies

[55] The impacts or potential impacts of pesticides on biodiversity have received little recognition in New Zealand, at least at a government level. Whilst the 654 page report on the state of New Zealand's environment (Taylor, Smith, Cochrane, Stephenson, Gibbs, Saunders, Swain & Wall 1997) referred to pesticide contamination of soil, groundwater and the marine environment, and contained a 167 page section on biodiversity, it failed to make any link between the two. The subsequent draft strategy on biodiversity also failed to mention pesticides (DoC & MfE 1998).

[56] Rudolf Bahro (1994, p.144-7) also referred to egocentricity in the context of anthropocentrism, but in the more general sense of the inability of humanity to experience the world in any way other than in relationship to itself.

the approach of pesticide manufacturers and many who use pesticides. Individual elements of the agri-ecosystem are manipulated in order to achieve greater monetary profit. The insecticide is applied to kill the insect pests, with little regard for its effects on non-pest insects or other species, or the overall health of the agri-ecosystem, let alone the wider ecosystem.

The homocentric ethic is a utilitarian one, deriving from the work of Jeremy Bentham and John Stuart Mill, in which the approach to the environment is one of "the greatest good for the greatest number of people for the longest time" (Merchant 1996, p.214). This is a social interest ethic which places the needs of society over those of the individual, but which still regards the environment as there solely, or primarily, for human gain. This is the ethic that theoretically characterises current pesticide regulators and pesticide policies based on the calculus of benefits and costs. It is questionable whether the 'longest time' factor is included in the risk benefit analysis, for this would suggest that the effects on future generations are factored into that analysis, and indeed the effects on the evolutionary path of nature and what they might entail for humanity, which is not in fact the case.

The homocentric ethic also underpins the shallow ecology approach, characterized by Norwegian philosopher Arne Naess in the 1970s, and in particular in his article "The shallow and the deep, long-range ecology movement: a summary", printed in 1972 in *Inquiry*, the journal he founded in 1958 (Glasser 1996, p.157). By shallow ecology Naess (1972, p.120) meant the concept that pollution and resource depletion must be controlled for the sake of the health and affluence of developed countries, what American sociologist Bill Devall (1980, p.125) referred to as 'reformist environmentalism', which takes place without challenging the prevailing social paradigm of domination. There is no major shift in ethics or practice. Scientific management and technological innovation are relied upon to fix the problem (Glasser 1996, p.167). Nature is valued as a resource for human wealth-generation.

In stark contrast, the ecocentric ethic espouses the concept of intrinsic valuation of nature. There is no one definition of intrinsic value, for its nature continues to be hotly debated. The notion of intrinsic value was traced, by Preston (1998, p.425), to Cambridge philosopher GE Moore. It was the "summary maxim" of Aldo Leopold's 'land ethic', according to Callicott (1989, p.140): "a thing is right when it tends to preserve the integrity, stability and beauty of the biotic community" (Leopold 1949, p.224). Environmental philosopher Holmes Rolston III argued strongly in favour of intrinsic values of nature (e.g. 1981, 1982, 1988). A heated philosophical and epistemological

debate has ensued, centering round the criticisms by philosophy professors J Baird Callicott and Bryan Norton of Rolston's views, and of those of each other (e.g. Callicott 1989, 1996; Norton 1991, 1992). Other writers have also entered the fray in support of, in opposition to, or in an attempt to explain Callicott, Norton and Holmes (e.g. Cheney 1992; Lee 1996; McQuillan 1998; Preston 1998). It is not the intention here to contribute to that debate, merely to note its existence, for the lack of agreement can be expected to be reflected in the manner in which the term is interpreted in policy and in law. The debate centres on objectivism, subjectivism, and relativism—principally the notions of intrinsic values residing in nature itself, or the beholder of nature, and or in relational properties such as rarity.[57] It is an important issue, for, as will be demonstrated, the manner in which the term is interpreted is vital to determining how it is incorporated into law, and subsequently put into practice. Suffice it to note here that its interpretation with regard to an ecocentric ethic involves the principle of nature possessing value independently of any valuation made by humans, i.e. that the source of the value lies in nature rather than in human preferences and attitudes (O'Neill 1992, p.120). That is the approach that is adopted with an ecocentric ethic.[58] Its interpretation on the basis of an anthropocentric approach provides for the source of the valuation to be the beholders of nature rather than nature itself, and this incorporates the relational property of rarity, and existence value, i.e. non-use value of nature to humans.[59] The relationship between the three types of valuation, and the three 'centrisms' is depicted schematically in Figure 5.1.

Figure 5.1 Schemata of ethical approaches to the valuation of nature

Valuation of Nature

Anthropocentric Ecocentric

[57] The debate surrounding the anthropogenic nature of all valuation is noted, but not furthered here, for the finer points of this aspect of the ethical discussion are not considered to be relevant to the practical application of an ecological rationality to pesticide policy.

[58] That is also the approach adopted by the Earth Charter. The penultimate draft referred to "the intrinsic value of all beings" (Earth Charter Campaign 1999), but in the final draft the wording was altered to "every form of life has value regardless of its worth to human beings" (Earth Charter Campaign 2000), thus making its interpretation of intrinsic value quite clear.

[59] There is considerable plurality in the use of these terms. Existence value is sometimes also referred to as inherent value (e.g. Caldwell 1988). Inherent value may also be used synonymously with intrinsic value if the latter is viewed from an anthropocentric approach (e.g. Caldwell 1988). Norton (1991, p.235) provided slightly different definitions, but they tend to confirm inherent value as existence rather than intrinsic value. Hence, the term existence value is used here for clarity. Paul Taylor (1986, p.75) used the term inherent worth in place of intrinsic value, differentiating them both from inherent value.

Egocentric	Homocentric	
Utilitarian	Existence value	Intrinsic value

Intrinsic valuation in New Zealand law

Bosselmann (1995, p.132) noted the beginnings of an ecocentric ethic in several recent pieces of New Zealand legislation, namely the Environment Act 1986, the Conservation Act 1987, the RMA 1991, and the HSNO Act 1996. All four Acts have legally enshrined the concept of respect for the intrinsic values of ecosystems. However, Bosselmann also noted that the ecocentric approach behind the development of the legislation "didn't last the distance" (1995, p.132).

The introduction of intrinsic values (not rights) into the legal system has not lived up to its original ecocentric promise largely, it is contended, because of the failure to grasp the nature of the ecocentric ethic, and a refusal to forsake the anthropocentric approach. Thus, eight years after its inclusion in the RMA, there is scant evidence of actual application of intrinsic valuation in management of the environment, with respect to usage of pesticides. Arguably, damage to the ecosystem has been lessened in some areas, but not, it is contended, as a result of the application of that ethic. Perhaps of significance in this context is the failure to include in the RMA the Māori concept of mauri, despite the proposal to do so by the Ministry for the Environment's Review Group on the Resource Management Bill (Randerson, Crosson, Salmon, Tremaine & Wheeler 1991, p.12,143,144).[60] Mauri cannot be translated exactly into English but it involves the concept of the life principle, or life force. ERMA (1999a) further defined mauri as involving "spiritual integrity" (p.8). Respect for the mauri of natural systems such as rivers is fundamental to Māori culture. It finds resonance with an ecocentric approach to intrinsic valuation of nature.[61] It is, however, specifically different from the

[60] Randerson *et al.* (1990) noted that the concept of mauri is accepted by "decisions made under existing planning legislation" and that "the High Court and the Court of Appeal, relying on the expertise of the Waitangi Tribunal in this area, have accepted the relevance of Māori cultural and spiritual values in resource management" (1991, p.12). Mauri was removed from the Bill by Parliament.

[61] Bosselmann (1995, p.244) noted that the Māori concepts of tapu and mana also "stand for the intrinsic rights and intrinsic values of nature". Tapu means under a restriction that is of a religious nature, often referred to as sacred. It can apply to places as well as things and may arise for many reasons. Mana means vested with authority, influence or power (Williams 1975, p.385,172).

New Zealand legal definition of intrinsic values which relies on a scientifically delineated approach. With the removal of mauri from the definition there was a return to mechanistic science:

> "Intrinsic values", in relation to ecosystems, means those aspects of ecosystems and their constituent parts which have value in their own right, including—
> (a) Their biological and genetic diversity; and
> (b) The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience:
>
> Resource Management Act 1991, section 2.[62]

The RMA requires that:

> all persons exercising powers and functions under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to . . . intrinsic values of ecosystems.
>
> Resource Management Act 1991, section 7.[63]

There are four problems with this approach from an ecocentric perspective. Firstly, those exercising powers and functions under the Act are members of central and local government, thus it is only they that are required to have particular regard to intrinsic values. Users of pesticides are not required to exercise this regard. Secondly, intrinsic values tend to be recognised only in terms of ecosystems, not in terms of individual members or member species of the ecosystem.[64] Thirdly, the issue of intrinsic values is couched in terms of only "particular regard", not in terms of a requirement for equal weight to be given them, or indeed any rights at all.[65] Fourthly, the requirement for particular regard is couched in terms of managing the use of resources. In other words, the intent is that humanity continues to manage resources to their own ends, being

[62] The same definition occurs in the HSNO Act 1996, section 2.

[63] The HSNO Act replaces the words "have particular regard to" with "take into account" (section 6).

[64] The Act, in fact, provides an open-ended definition of the term intrinsic values, meaning that it could be argued to include individual species and individuals of a species. However, section 7 relates intrinsic values specifically to ecosystems alone, and in practice it is ecosystems not individual members of a species that receive attention in the context of the RMA e.g. *Southland District Council v Southland Regional Council* C029/97, *Parata v Northland Regional Council* A53/99. The Environment Act 1986 relates intrinsic values only to ecosystems, whilst the Conservation Act 1987 relates them to individual species. Connelly and Smith (1999) warned of the problem of "assigning too little value to the individual and too much to the whole" (p.17), a criticism they levelled at Leopold's land ethic, which was based on the integrity and stability of the biotic community.

[65] Intrinsic values were included as part of the definition of sustainable management in the original draft of the RMA, but subsequently removed.

mindful of the diversity and integrity, form, functioning and resilience of ecosystems. This use of intrinsic valuation is a far cry from the intent of the ecocentric ethic, in which individual species, *and* individual members of species, are recognised as having value outside of human valuation, and beyond the mere ecological health of an ecosystem, the latter being the only apparent concern of the RMA's anthropocentric version of intrinsic values.

This understanding of the use of the term intrinsic values in the RMA and HSNO is leant weight by an explanation from ERMA relating to their functions under the HSNO Act:

> At a practical level, the Authority will take into account the intrinsic value of ecosystems by considering whether the organism or hazardous substance is likely to destabilise the natural evolution of ecosystems which are valued for their own sake, i.e. irrespective of any instrumental value they may have.
>
> ERMA 1999b, p.13.

Here ERMA revealed confusion of the concept of intrinsic value with that of existence value. In fact, it commented that intrinsic value is sometimes referred to as existence value, or non-use value. It confirmed that it is using an anthropocentric approach to the term intrinsic value by going on to say that empirical measures of intrinsic value may be obtained through questionnaires. The point is that, in an ecocentric ethic, intrinsic valuation does not stem from humans as is indicated in the above quote, but resides in nature itself. Hence, to refer to ecosystems as being "valued for their own sake" displays an adherence to the anthropocentric ethic. The definition in the Act does not explicitly ascribe an anthropocentric approach to intrinsic valuation, in that it does not state that intrinsic valuation is human valuation. It can however be gleaned from its interpretation by ERMA.

Additionally, both Acts rely on a reductionist science approach to intrinsic values, which is inconsistent with ecological rationality. This is revealed again in the ERMA statement above, with the depiction of intrinsic value as being only the stability of the natural evolution of ecosystems. It seeks to find intrinsic value in only certain defined characteristics of nature. This, too, falls well short of the ecocentric approach to intrinsic valuation.

In summary, ERMA was stating that intrinsic valuation applies only to the natural evolution of ecosystems that are valued by humans for non-use reasons. This approach is totally inconsistent with the more widely accepted ecocentric understanding of the term as described previously in this chapter. Even if ERMA's view were accepted as

being the correct view of intrinsic valuation, it is contended their approach is in fact meaningless, given that the stability of the 'natural evolution of ecosystems' has become so deeply compromised by humanity's actions. How will the Authority determine the stability or otherwise of the natural evolution of an ecosystem, especially in the face of chaos and complexity theories, and the suggestion by Landis that natural ecosystems are not in fact stable at all? In the agricultural sense there is no natural evolution of the system, for it is not a natural system, although it could be argued that an overrun of weeds and pests until biological control asserted itself would constitute natural evolution. Hence, logically, there can be no regard paid to intrinsic values with respect to pesticides using ERMA's interpretation. Yet the HSNO Act specifies that there shall be. There is a failure of rationality.

Thus, it can be seen that the inclusion of intrinsic values in recent New Zealand legislation, whilst it does reflect an increasing regard for environmental values, does not in fact reflect an understanding of an ecocentric ethic. The definition of intrinsic value relies solely on aspects of the ecosystem that have been derived by a reductionist approach and which can therefore be measured by mechanistic science. A mechanistic approach to intrinsic value means that, when science is unable to identify an adverse effect on the environment by a particular process or product, then that process or product is reckoned to meet the intrinsic interests of nature, i.e. to not be in conflict with them. The upshot of this is that interpretation of the law must also rely on a mechanistic science approach, and must therefore of necessity rule out all aspects of an ecocentric approach to nature that do not comply with mechanism, including Maori principles of mauri and tapu. An example in point is the case mentioned in Chapter 1, *Marie Philomena Grunke v. Otago Regional Council* C008/96, in which the judge ruled that the spraying of the herbicide Roundup into a river did not offend Maori principles because it was unlikely to be at odds with the environmental bottom lines established by the scientific paradigm. Clearly, then, an ecocentric approach has not been taken.

For this to occur policy and law must incorporate values other than those offered by modern science. Mauri is a principle that is not measurable and hence not understandable by science, in the same manner that the principle behind homeopathic medicine is not understandable by science—for it too recognises the 'life force' and relies wholly upon this principle to effect a cure. Some of the effects of homeopathic medicine can be measured, and indeed have been, as was reported in Chapter 4. However, its operating principle remains outside of modern science's methodologies—, as does the concept of mauri. Not until the latter concept and that of the intrinsic value of non-

human nature, other than ecosystem stability, are recognised in law as of worth equal to that of human use of the environment will there be an operational ecocentric ethic:

> The role of enlightened self-interest in environmental politics as a spur to environmental action is of the greatest importance and its practical political value should not be underestimated; but it does not amount to an environmental ethic. Whilst including such instrumental concerns, an environmental ethic needs to go beyond contingent human interest and the direct relation between the environment and human welfare.
>
> Connelly & Smith 1999, p.19.

In order to understand how the ecocentric principle of intrinsic value can be applied to pesticide policy, it is useful to understand how the principle came to be written into New Zealand law in its current form. For this reason, it is instructive to look at material written in the period preceding enactment of the law, during which the legal principles were effectively established. During this period, Jennifer Caldwell (1988) drew attention to the determinedly anthropocentric approach of the impending legislation, in that the government's primary purpose was seen to be "resource allocation and management" aimed at producing "an enhanced quality of life, both for individuals and the community as a whole" (p.1)—in other words for humans only.[66] She noted the normal ecocentric approach to intrinsic valuation:

> Intrinsic value is, by the conventional purist objective definition, value that exists in the environment and its components independently of human existence, preference or considerations.
>
> Caldwell 1988, p.2.

Caldwell (1988) then noted, however, that a "utilitarian flavour" to intrinsic values was suggested by "the overall Government aim of producing an enhanced quality of life for the community" (p.3), although the logic of this deduction is debatable.[67] Caldwell also argued that the ecocentric approach to intrinsic valuation cannot be taken into account in decision-making processes "because it cannot be realised without a fundamental compromise of the concept itself" (p.5), for to do so makes it "immediately subject to human preferences" (p.6). It is contended that this is a false premise, based on the equally false premise that in order to incorporate the concept into decision-making it must be located and measured (Caldwell 1988, p.6). It will be argued in the next section

[66] Caldwell, Department of Conservation, author of a report prepared for the Resource Management Law Reform Core Group.

[67] It can more logically be argued that the enhancement of life for the community can be better achieved by respecting nature as of value in its own right.

that intrinsic valuation can easily be incorporated into pesticide policy and by extension other policy, without a need to locate and measure it. Caldwell (1988) acknowledged that the ecocentric view of intrinsic valuation "has great merit, not least because it is "accurate" and "ethical" (p.7), but even so failed to support it because in her view "legal structures . . . cannot be expected to give legal meaning and effect to values which are compromised simply by human considerations". No argument was presented in support of this assumption. Instead, she supported the use of "surrogate values", derived from human benefits obtainable from inherent valuation of the environment and natural resources" (p.8), inherent values being human non-use valuation.

Thus was the current legislated anthropocentric approach to intrinsic values apparently derived. It was influenced, at least in part, by recommendations from the Department of Conservation based on an unfounded assumption that the ecocentric version could not be incorporated into law. It was probably also influenced by other writers, such as Graeme Scott of the Centre for Resource Management in Canterbury who, in the period immediately leading up to the development of the RMA, expressed the view that intrinsic values of nature should be "located in the 'proper functioning' of the biosphere" (Scott 1986, p.185). Scott rejected the notion that individual species, let alone individual members of species can have intrinsic value, as is held by ecocentric ethics, because of a concern about an implied ethic of kinship with humans on the basis of social contract theory (Scott 1986, p.180-5).[68] Scott saw the intrinsic value of an organism as being measured by the contribution it makes to important ecological processes (p.180). If this logic was applied to humans, it would mean that individual humans have no intrinsic value, but are valued only on the basis of their contribution to the proper functioning of the biosphere, or perhaps economic sphere, a notion that is also rejected by ecocentric ethics, as well as by human rights theory. Alastair Gunn (1988) also located intrinsic value in Leopold's ecosystem "stability, diversity and beauty", in the conservation of native species, and of "natural and historic resources" (p.86).[69] Apparently, introduced species of birds, such as the song thrush, have no intrinsic value. Gunn's approach was decidedly anthropocentric, for he located intrinsic value in "those things of which we are trustees for future generations . . . which sustain us and help us flourish" (p.86). Karen Cronin (1989) of the Ministry for the Environment picked up both Scott's and Gunn's work in her review of intrinsic value for the Resource Management Law Reform Group. In so doing, she also emphasized the ecosystem approach to intrinsic values (Cronin 1988, p.8) without questioning the implied exclusion of value adhering to individuals.

[68] It should be noted that the ethic of kinship with nature underlies Maori spiritual philosophy.
[69] Alastair Gunn, Department of Philosophy, University of Waikato, New Zealand.

Thus it transpired in the RMA: attention directed solely to ecosystems.[70] This failure to ascribe value to individuals is, it is contended, an essentially anthropocentric approach that enables humans to harm or kill individual members of a species safe in the knowledge that they are not, they hope, interfering with the stability of the ecosystem and hence intrinsic values. This view then finds the expression in an interpretation of intrinsic values that allows for maximising human use of the environment whilst also achieving sustainability of that environment, as was proposed in a Treasury paper to the Resource Management Law Reform Group (Wilson 1989).

Lastly, as an indication of the ongoing confusion in the use of the term intrinsic values in New Zealand government policy, it should be noted that in the 1998 draft strategy on biodiversity the term is considered in the light of an "ethical responsibility" and applied to "species and life forms", rather than to ecosystems (DoC & MfE 1998, p.22). However, it is couched in an ambiguous sense, indicating that the responsibility may not apply to all life forms, only those that "warrant our respect", respect presumably residing in the heart of the beholder (DoC & MfE 1998, p.22).[71] Note, here, the difference between this perspective and the Maori perspective:

> The Western environmental management system however, values the natural world, (trees, plants, mountains, streams, rivers, and so on) only in so much as it is meaningful to humans. Tupuna Maori would say that these things have value in themselves, that whether humans are here or not, the trees still retain their mana, the birds still retain their mauriora, the mountains retain their tapu: they remain taonga.
>
> Te Kaunihera Maori O Tamaki Makau Rau/Auckland District Maori Council 1995, p.1,2.[72]

Certainly the legal recognition of the intrinsic value of nature has taken humanity a little way along the path towards an ecocentric ethic, but of itself it is insufficient as long as the domination/anthropocentric principle still holds sway—through the interpretation

[70] A 1990 discussion paper from the Review Group stated that there were only two options with respect to intrinsic values in the Resource Management Bill: delete them altogether or "refer specifically to 'intrinsic values of natural ecosystems'" (Randerson *et al.* 1990, p.9).

[71] Full text of third principle for managing New Zealand's Biodiversity (DoC & MfE 1998, p.22):
3. Ethical responsibility
People and communities have responsibilities for the conservation and sustainable use of biodiversity beyond their own needs:
- to the needs of future generations
- to other species and life forms, which have intrinsic value and warrant our respect; and
- to the nation and the rest of the world.

[72] Tupuna Maori means ancestors of the Maori people. Mauriora means life principle, same as mauri. Taonga means highly prized (Williams 1975, p.458,197,381).

of the concept in terms of human values and mechanistic science, and through the making of policy by the powerful few in a manner which reinforces the particular worldview of that science and disempowers all others. Until those two factors give way to a different approach, ecocentrism will remain but a theoretical concept. Naess, Fox, Bosselmann, Prue Taylor, The Earth Charter Campaign, and others have drawn attention to the need for attitudinal change if an ecocentric ethic is to be implemented. Simply changing the legal wording, or the policy description is insufficient in the absence of understanding of the underlying philosophy of respect and interconnectedness, of the relationship between self and nature, and humanity's essential situation as part of nature. Without that understanding, there will always be the potential for good intentions to be perverted by policy makers, or the good intentions of policy makers to be perverted by policy implementers. The manner in which ERMA have interpreted intrinsic values, as described above, is perhaps illustrative of this point.

Intrinsic valuation lies at the very heart of the ecocentric ethic, along with that other theme, the interconnectedness of all beings. It was framed as "biospherical egalitarianism" in the seven principles that Naess espoused as characterising deep ecology (Naess 1972, p.121). Philosopher George Sessions (1991, p.140) reported that the two main tasks of deep ecology are that of encouraging an egalitarian attitude towards all entities in the ecosphere, and conversely that of dismantling anthropocentrism. Above all the purpose of deep ecology is to contribute towards ecologically responsible policy "through systematic and methodical exploration of perceptions, values, actions, policies", according to Harold Glasser (1996, p.166).[73] Naess's views therefore are of importance in the development of ethical pesticide policy.

Which Rationality?

In conclusion, pesticide policy must, logically, be based on either technological or ecological rationality, on an anthropocentric or an ecocentric ethic. The resulting policy ultimately will depend on which rationality and ethic are incorporated. It is at the very beginning of policy development that this decision must be taken, for all subsequent decisions depend on this choice. Normally, no such decision is ever taken, simply a technological and anthropocentric approach is assumed without question, analysis or justification. It is contended that ethical pesticide policy development must state clearly which approach to the valuation of nature is to be taken. Further, it is contended that an ethical policy must take an ecocentric approach that recognizes the interdependence of

[73] Glasser, Department of Humanities and Social Sciences and Centre for Policy Studies, New Jersey Institute of Technology, Newark, USA.

nature and proceeds from the basis of recognition of intrinsic values of nature both in the present and in the future. Such an approach is partially supported by recent New Zealand legislation and international treaties, although it is contended that these have generally failed to implement the principles of an ecocentric ethic adequately. More importantly, an ecocentric approach is the logical choice because its rationality has been demonstrated. Conversely, Chapters 3, 4, and 5 have demonstrated that risk assessment based on toxicology and ecotoxicology incorporating an anthropocentric ethic is flawed, and therefore basing policy processes and decision-making on risk assessment reliant upon these disciplines is irrational. Toxicology is flawed precisely because it applies a mechanistic approach to nature and ignores the interconnectedness that is fundamental to ecocentric rationality. Thus, it is contended that mechanistic toxicology cannot assist with the interpretation of intrinsic values in an ecocentric sense, and current legalistic attempts that require consideration of these values are meaningless:

> Scientific analysis is limited to a domain of experience from which rights, whether they are moral, ethical or legal, have been systematically eliminated. There are no rights, even of existence, which are considered to be intrinsic to Nature. . . . Science recognises no natural rights.
>
> Wills 1995, p.3.

A final word about the choice between ecological and technological rationality is necessary. It is important to understand that the selection of an ecological ethic does not mean that all technology is eschewed. It simply means that decisions regarding, in this case pesticides, begin with an understanding of ecological reality and are consistent with that reality. How this can be undertaken will be explored below. An ecological ethic requires the addition to that rationality of a respect for nature:

> That land is a community is the basic concept of ecology, but that land is to be loved and respected is an extension of ethics.
>
> Leopold 1949, p.viii-ix, cited in Norton 1991, p.55.

5.3 Application of an ecological ethic to pesticide policy

In the preceding analysis of ecological rationality and ethics, only two of many possible themes were analysed. These two were selected because of their constant occurrence throughout environmental philosophy, and because they are both vitally important to pesticide policy. The strand of environmental philosophy that has been selected for application to pesticide policy is that of ecocentrism. This is because of its internal

coherence, broad encompassment of other ecological themes, and because, in the words of Caldwell, it's view of intrinsic value is accurate and ethical. Prue Taylor (1998b) referred to the ecocentric ethic as "the most encompassing" ethical approach (p.35). In addition, postmodern science supports its central tenet of the interconnectedness of all elements of the ecosystem.

Before applying an ecocentric ethic to pesticide policy, it is worth briefly reviewing aspects of it other than the two previously analyzed. The elements of this ethic, as summarized by Robin Eckersley (1992, p.46), are:

i. recognition of the full range of human interests in the non-human world, including resource conservation and human welfare;
ii. recognition of the interests of the non-human community, including the concept of intrinsic value;
iii. recognition of the interests of future generations of humans and non-humans; and
iv. adoption of a holistic rather than a mechanistic perspective, in that populations, species, ecosystems and the ecosphere, as well as individuals, are valued.

It is contended that each of these elements should be addressed in the development of pesticide policy. They are, however, interconnected and must be addressed in a fashion that is consistent with that interconnection. The greatest challenge in implementing an ecocentric ethic is how to address the 'competing claims' of humans and non-human nature, essentially points i and ii above.

5.3.1 The partnership approach

Perhaps the first step is to recognize that regarding the two aspects of nature, human and non-human, as being in competition with each other is likely to lead to a repetition of the anthropocentric approach underlying technological rationality, which places human interests ahead of non-human interests. A more logical approach, one that is consistent with ecological rationality, would be to regard the relationship as one of partnership rather than competition. It might be worth thinking of this relationship in terms of ordinary human business or personal relationships that are based on mutual assistance and cooperation and which require compromise and respect rather than competition.

Merchant (1996, p.216-24) proposed a partnership approach in which there is equity between human and non-human communities, a mutual relationship that admits the homocentric ethic of human needs, but also admits the rights of nature to continue to

exist. The grounding principle of this approach is the equal relationship between humans and nature rather than the dominance of one's rights over those of the other. It contains an acknowledgement of humanity's ability to destroy nature along with itself, and of nature's temporal precedence and succession of humanity. Merchant, in fact, developed the partnership approach as an 'ethic' separate from the ecocentric ethic, partly because of what she described as "wholistic fascism" (p.216) in ecocentrism, the favouring of the whole at the expense of the individual. It is contended that this is a misinterpretation of ecocentrism, for the definition provided by Eckersley, and reported above includes individuals as well as ecosystems.[74] Another reason Merchant (1996) gave was the need to include elements of social justice, such as respect for cultural diversity, and "inclusion of women, minorities and non-human nature in the code of ethical accountability" (p.217).[75] It is further contended that these elements of social justice are not inconsistent with an ecocentric ethic, although not specifically spelled out in Eckersley's definition, and some of these areas will be addressed in the next two chapters with the further development of the ethical policy process. Thus, a partnership approach is consistent with an ecocentric ethic as presented in this thesis. This partnership approach is echoed in Bosselmann's (1995, p.127-8) 'eco-politics', in which the interests of the human users of the environment are integrated with those of non-human aspects of the environment through law.[76] Priority is given to neither interest, but rather to a balancing of interests. In this way, the 'conflict' between human and non-human interests is not abolished or suppressed but rather addressed in a solution-oriented equitable manner.[77]

Partnership as distinct from stewardship

Before discussing what this approach might mean for pesticide policy, it is important to first describe how it differs from the stewardship/guardianship approach already, tentatively, recognised by New Zealand legislation. The inclusion of intrinsic values in

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[74] However, Merchant's description does fit that of the definition of intrinsic values in New Zealand law as previously discussed, and also Leopold's land ethic.

[75] The four precepts of Merchant's partnership ethic are:

- Equity between the human and non-human communities.
- Moral consideration for humans and non-human nature.
- Respect for cultural diversity and biodiversity.
- Inclusion of women, minorities, and non-human nature in the code of ethical accountability. (Merchant 1996, p.217).

[76] Some writers, such as Dryzek (1995, p.587), view an ecocentric ethic as meaning that priority is given to ecological values. However that is not the view adopted in this thesis.

[77] See also Paul W Taylor's (1986) principles for decision-making based on respect for nature, later in this section.

the RMA and HSNO Act, although not in a manner consistence with an ecocentric ethic, has been noted previously in this chapter. In addition to intrinsic value, the RMA included the concepts of stewardship and kaitiakitanga.[78] The latter term will be elaborated upon below, but first the meaning of stewardship needs examining in light of an ecocentric ethic. A succinct analysis of the traditional meaning of the term is provided by James Connelly and Graham Smith (1999, p.11-2).[79] Essentially, they see it as being weakly anthropocentric and derived from the same Judaeo-Christian heritage that gave the world the domination principle.[80] As already referred to in footnote 14, this chapter, there exists alongside the interpretation of Genesis as directing man to rule over nature, an alternative interpretation that God appointed mankind as stewards to look after nature on behalf of Him. Connelly and Smith provided the following quotation in support of their argument:

> Stewardship is today the generally accepted understanding within Christianity . . . of the role given to humanity in creation, in its relations with the rest of nature. This can be interpreted as co-worker with God in creation, but in no sense as co-equal. For it signifies that humanity's position is that it is tenant and not owner, that it holds the earth in trust, for God and for the rest of creation, present and to come.
>
> Watson & Sharpe 1993, p.222-3, cited in Connelly & Smith 1999, p.11-2.

Thus, the term stewardship can be seen to have not only a Christian religious connotation, but also an approach that places humanity above nature, as a landlord, or a trustee. This is quite a different concept to that of equality as proposed by the ecocentric ethic, by Merchant's partnership ethic, and by Bosselmann's eco-politics approach. Prue Taylor (1998b) took a more generous approach towards the terminology, suggesting that the term ought simply to imply "active concern and care, in the interest of all life, not in the superior interest of humanity" (p.302). Callicott (1994) submitted a similar view, referring to the ethic associated with stewardship as being an "ecocentric environmental ethic" (p.21). He went on to state that it is "the most effective, practical, and acceptable environmental ethic consistent with the Judeo-Christian worldview" (p.21). Callicott also proposed that the presence of God in the Judaeo-Christian religion provides an axiological reference point for the source of value in nature—without God and His "divine fiat" (p.22) there is a difficulty in finding a source of value. This harks back to the

[78] These concepts are absent from the HSNO Act.
[79] Connelly, Head of Political Studies at Southampton Institute; Smith, Research Fellow at the University of Strathclyde.
[80] P Taylor (1998b, p.301) took the debate back to Socrates, Thrasymachus, and Plato.

epistemological argument mentioned earlier regarding the source of intrinsic valuation, whether it is in nature itself or the eye of the beholder.

Certainly Prue Taylor's (1998b) view of stewardship has more in common with the Maori concept of kaitiakitanga than that provided by Connolly and Smith, for whilst kaitiakitanga also has a spiritual derivation, it appears to suggest slightly more equality with nature. Kaitiakitanga is defined in the RMA Amendment Act 1997, No. 104, as follows:

> Kaitiakitanga means the exercise of guardianship by the tangata whenua of an area in accordance with tikanga Maori in relation to natural and physical resources; and includes the ethic of stewardship.
>
> Resource Management Act 1991, section 2.[81]

ERMA sees the Maori cultural terms kaitiakitanga and rangatiratanga as expressing the principle of inter-relatedness (Welsh 1999, p.3), referring specifically to the relationship between humans and non-human nature. Traditional Maori relationship with the environment is based on interrelatedness and interconnectedness of all living things of the natural world. Other writers have used differing terms to express this relationship. For example, Lynette Jarman, Maever Moeau-Punga and Peter Moeau (1996) referred to the concepts of common descent, whakapapa, and kinship-like relatedness, whanaungatanga, as expressing this relationship between human and non-human nature (p.91).[82] Jarman *et al.* quoted the Reverend Gray's description of karakia, a Maori form of spiritual expression which:

> . . . bears witness to the interlocking spheres of the natural world, the Universe and humankind. . . . It testifies to the indivisibility of God, nature and humankind, actively relating to each other as one continuous and coherent life cycle.
>
> Gray 1995, cited in Jarman *et al.* 1996, p.91.

These concepts appear similar to the relationship espoused by an ecocentric ethic, yet J.E. Ritchie was quoted in Jarman *et al.* as determining the Maori view as:

> . . . frankly and openly anthropomorphic; the environment is entitled to the same care we would lavish upon ourselves as it is the metaphoric and mythic, in cultural terms, actual tipuna.[83]

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[81] Tikanga Maori is defined by the RMA as meaning Maori customary values and practices.

[82] Jarman, Te Korowai o Kai Tahu; Moeau-Punga, Rongowhakaata, Te Aitanga-a-Mahaki, Ngati Ruapani, Ngai Tamanuhiri, Ngati Hine Hika, Rongomaiwahine; Moeau, Centre for Maori Studies and Research, Lincoln University, Canterbury.

[83] Tipuna means ancestor, and thus has the same meaning as tupuna (Williams 1975, p.422).

Ritchie, cited in Jarman *et al*. 1996, p.92.[84]

Jarman *et al.* (1996) stated that Maori see themselves "emanating from a divine source" and that they identify with the concept of mana putaiao or "interpersonal responsibility" (p.94):

> We feel the connection to all living things on the face of the earth and give our blessings to their right to exist also.
>
> Jarman *et al*. 1996, p.94.

So it would seem that the Maori concept could be best translated into a pakeha concept that contained elements of both the anthropocentric and the ecocentric approaches. Interestingly, Jarman *et al*. (1996, p.93) noted that many Maori do not agree with the RMA definition of kaitiakitanga as being that of 'guardianship', and including 'stewardship', for they see it as being too limiting to adequately describe the Maori "social framework" (p.92).

Thus, despite Callicott's advantage of God's 'divine fiat', which skirts the epistemological argument of the source of intrinsic valuation, the stewardship approach is rejected, not least because of its strong Judeo-Christian link. Many people, including Maori and non-Maori New Zealanders derive their value systems from sources other than Judaism or Christianity, and therefore, it would seem more appropriate to develop an ecological ethic that is separate from, but does not exclude the latter belief systems. More importantly, it is contended that as long as technological rather than ecological rationality is applied to policy, such as is the case with current pesticide policy, there is the distinct danger that the stewardship approach will be interpreted in a strongly anthropocentric manner, reinforcing that rationality. That anthropocentric manner is revealed by the Oxford Dictionary definition of a steward as including "an official appointed to control . . . an administrator and dispenser of wealth, favours; . . . a person employed to manage the affairs of the estate" (Brown 1993, p.3055). It is also revealed by policy analyst David Schnare's (1995) discourse on the stewardship ethic, in which he described one of twelve aspects of this ethic thus: "the purpose of stewardship is to promote as much environmental quality as humans want and can afford" (p.324).[85] Schnare then stated his view that "environmental quality is neither a duty not a right, it is a public good" (p.324). Thus, he has excluded any notion of intrinsic value from stewardship. Graeme Scott also rejected the stewardship approach:

[84] Ritchie JE. 1993. Details not included in Jarman *et al*. 1996.

[85] Schnare, Senior Policy Analyst, Office of Enforcement and Compliance Assurance, US Environmental Protection Agency, Washington, D.C.

> . . . not so much out of its essential nature (or what it could be) but rather out of what it has become. Stewardship has become humanism—anthropocentrism.
>
> Scott 1986, p.176.

Therefore, in this instance where a paradigm shift is required to move pesticide policy from technological rationality to ecological rationality, it is considered useful to view the appropriate relationship between human and non-human nature as a partnership. The latter approach intuitively acknowledges that, whilst humanity has the power to order nature on the one hand, nature has the power to limit and order humanity on the other, particularly with respect to the interaction between climate and agricultural systems. Humanity can destroy biodiversity with its pesticides, but nature can destroy crops overnight with climatic 'events'. The lack of apparent intent in the latter instance has no bearing on the results.

In summary then, the ecocentric principle of equal moral consideration of human and non-human nature best finds expression in the partnership approach advocated by Merchant, and in the eco-politics espoused by Bosselmann. It is distinctly different from the stewardship ethic, which can be seen to retain a dominant role for humanity and hence human interests, and which therefore struggles to admit the intrinsic interests of nature. It would appear that Maori cultural principles, whilst containing elements of an anthropocentric approach may be more nearly aligned with an ecocentric approach than with the Christian ethic of stewardship.

5.3.2 Interconnectedness of nature and pesticide policy--the principle of minimum intervention

Although the above discussion may seem to be a diversion from the real purpose of developing an ecocentric pesticide policy, the explanation of ecocentrism in terms of a partnership approach is in fact vital, for it sets the tone of the development of the policy. For, in the arena of pesticide use, humanity's basic survival needs can seriously threaten the interconnectedness of nature. Of particular relevance is the acknowledgement within Merchant's partnership ethic of humanity's continual need to modify nature in order to provide sustenance for its continued survival, the most basic instinct of all organisms in nature. Naess also acknowledged the necessity for "some killing, exploitation and suppression", presumably for the continuance of the human species (Naess 1972, p.121). Humanity needs food to survive. That food is largely produced using agricultural methods that have given rise to agri-ecosystems. These systems are neither natural nor highly stable. Some intensive systems, such as battery rearing of

animals and thousand-acre monocultures, can easily be conceptualized in Beck's (1995) term of "remoulded nature devoid of nature" (p.37). Nevertheless, they consist of elements of nature—plants, insects, micro-organisms—and humans are ultimately dependent on non-human nature in order to produce their food. In no other sphere of human endeavour is humanity so dependent on its relationship with non-human nature to fulfil its basic needs. Yet, in few other spheres is the interconnectedness of nature paid so little heed. The result is a high degree of ecological unsustainability of the agri-ecosystem, with adverse off-site and downstream effects on both human and non-human nature, some of which have been occasionally mentioned throughout this thesis.

Lady Eve Balfour provided a comparative description of pesticide-based farming and organic farming that demonstrates the latter's incorporation of ecocentric principles:

> Without a positive and ecological approach it is not possible to farm organically. The approach of the modern conventional farmer is negative, narrow and fragmentary, and consequently produces imbalance. His attitudes to 'pests' and 'weeds', for example, is to regard them as enemies to be killed—if possible exterminated. When he attacks them with lethal chemicals he seldom gives a thought to the effect this may have on the food supply or habitat of other forms of wildlife among which he has many more friends than foes. The predatory insects and the insectivorous birds are obvious examples.
>
> The attitude of the organic farmer, who has trained himself to think ecologically, is different. He tries to see the living world as a whole. He regards so-called pests and weeds as part of the natural pattern of the Biota, probably necessary to its stability and permanence, to be utilized rather than attacked. Throughout his operations he endeavours to achieve his objective by co-operating with natural agencies in place of relying on man-made substitutes. He studies what appears to be nature's rules—as manifested in a healthy wilderness—and attempts to adapt them to his own farm needs, instead of flouting them.
>
> Balfour 1977, p.6.[86]

Balfour described nature's rules as including diversity of species, protective soil cover, and topsoil on the top, i.e. not inverted by deep ploughing. Balfour also paid tribute to Leopold's land ethic and the concept of the community of life: "we must foster a reverence for all life, even that which we are forced to control" (p.7). In so doing, she

[86] Balfour (1899-1990), founder of the modern organic agriculture movement, with on-farm experiments beginning in 1939, publication of her seminal text *The Living Soil* in 1943, and the establishment of the Soil Association in the UK in 1945 (Balfour 1948; Langman, Stewart & Waller 1990).

provided an early forerunner of Merchant's partnership approach. Balfour had this to say about the application of an ecological approach to agriculture:

> There are two motivations behind an ecological approach—one is based on self interest, however enlightened, i.e. when considerations for other species is taught solely because on that depends the survival of our own.
>
> The other motivation springs from a sense that the biota as a whole, of which we are a part, and the other species which compose it and helped to create it, are entitled to existence in their own right. This is the wholeness approach.
>
> Balfour 1977, p.7.

The natural farming methods of Masanobu Fukuoka (1978), made famous by his book *The One Straw Revolution*, follow the workings of nature even more closely. Based on the Buddhist philosophy of nothingness, it operates on minimal intervention with nature and has achieved yields as high as those on conventional farms, on land in southern Japan that has not been ploughed or fertilized for more than thirty years (Fukuoka 1985, p.15). Fukuoka's philosophy of leaving nature alone was expressed in this sentiment:

> We often speak of "producing food", but farmers do not produce the food of life. Only nature has the power to produce something from nothing. Farmers merely assist nature.
>
> Fukuoka 1985, p.17.

Fukuoka's description of his rice paddy field exemplifies the interconnectedness of nature that underlies his natural farming system:

> As I walk through the paddy field, spiders and frogs scramble about, locusts jump up, and droves of dragonflies hover overhead. Whenever a large outbreak of leafhopper occurs, the spiders multiply too, without fail. . . . No matter that there are insect pests here. As long as their natural enemies are also present, a natural balance asserts itself.
>
> Fukuoka 1985, p.17.

Thus, it is clear that the ecocentric principle of the interconnectedness of nature best finds expression in an agricultural system that provides least intervention in nature's workings. However, few modern farming systems live up to the standards set by Fukuoka.[87] Organic and biodynamic systems are more common, and incorporate

[87] Tim Vallings (2000), a Northland avocado grower described the system employed by he and his wife Zelka, as a "natural farming" system, and indeed it has more in common with Fukuoka's approach than most other farming systems.

ecological concepts to a greater extent than chemical-based farming, relying on the interconnectedness of nature for effective management of pests, weeds and diseases, but they also tend towards a greater degree of intervention than Fukuoka espoused. Part of that intervention takes the shape of biological pesticides such as the insecticide *Bacillus thuringiensis*, as well as inorganic compounds such as copper and sulphur. These pesticides are not without adverse effects on both humans and the ecological system. Therefore, they fall within the ambit of current pesticide policies. Perfectly ecological farming may require no pesticides at all, and hence no pesticide policy. However, it may be a long time before this can be achieved on a countrywide scale.[88] Thus, in the interim, and certainly with the currently dominant agricultural system still based on chemical intervention, a pesticide policy has its place. What is required is one that best fosters ecological rationality. This requires recognition of the interconnectedness of nature, both those elements of the agri-ecosystem and those that lie outside its immediate boundaries but are continuous with it. It requires recognition of the need to *minimize* chemical intervention in pest, weed and disease management, not merely to *manage the risk* of such intervention. Thus, a pesticide policy consonant with an ecological ethic must be based on the concept of advocating minimal and decreasing use, and that only where necessary, rather than on advocating safe and efficient use:

> Ecological and organic agriculture is often referred to in India as *ahimsic krihi*, or "non-violent agriculture" because it is based on compassion for all species and hence on protection of biodiversity in agriculture.
>
> Shiva 2000, p.119.

5.3.3 Intrinsic values of nature in pesticide policy--the principle of minimum harm

The essential problem with the traditional approach to pesticide policy is that it begins part way through the process instead of at the beginning. It begins with the assumption that pesticides are required. This is an unproven assumption. Furthermore, its unquestioned adoption prevents the analysis of a number of prior policy questions. In Chapter 1, section 1.3, a list of key questions to be asked in developing an appropriate policy was posited.[89] Of these, questions one and five are important in this context:

[88] This is a comment on attitudinal problems rather than problems of productivity.

[89] 1.What exactly is the issue?
2. What is the current situation?
3. What has taken place previously?
4. What is known of the impact of previous actions?
5. What is the objective?

what exactly is the issue, and what is the objective? The issue has already been defined as pesticide use. The objective, however, is a different matter. Traditional policy tends to define the objective, generally, as enabling or promoting the efficient and safe use of pesticides, or of managing or reducing risks from pesticides. In the same manner others refer to 'sustainable use of pesticides in agriculture' (e.g. McNaughton, Holland, James & Clothier 1999). Both reveal an anthropocentric approach based on the assumption that humanity has a right, and a need, to lace the environment with pesticides in order to extract resources to satisfy human needs and wants. Such an assumption underlies the annotated methodology established by ERMA under the HSNO Act, which "reflects a premise that . . . with most applications [for registration] the issue is likely to be establishing conditions for effectively managing the risks . . ." (ERMA 1998, p.4). In other words, the methodology is established on the premise that pesticides are necessary and wanted.

However, if an ecocentric perspective is applied a very different approach must be taken to the objective. The exercise becomes how can humanity work with the natural environment to provide the sustenance required to support human existence, whilst causing the minimum damage to the intrinsic values of non-human nature? Pesticide use at once takes a back row seat. Use is no longer assumed to be necessary, and is no longer the prime focus of the policy, but rather pesticides become considerable as one of the tools that may, or may not, be appropriate to achieving the primary purpose, that of sustaining human existence with minimum harm to non-human nature.

This approach requires applying what was termed by Paul Taylor (1986) "the principle of minimum wrong" (p.263), one of five principles he developed as normative guides in decision-making.[90] This principle applies where the basic interests of non-human nature are in conflict with the interests of humans:

> The principle of minimum wrong lays down the requirement that actions taken by individuals in the pursuit of ends that lie at the core of their rational conceptions of their true good must be such that no alternative ways of achieving those ends produce fewer wrongs to wild living things. . . . The key test for moral permissibility is that certain nonbasic interests of humans may be furthered only under the

6. How is the objective to be achieved?
7. How is success to be determined?

[90] The other principles are those of self-defence, proportionality, distributive justice, and restitutive justice. Several years earlier Robert Goodin (1983) had included 'avoiding harm' as one of the fundamental ethical principles for environmental protection. The others are reversibility, comparing the alternatives, protecting the vulnerable, maximizing the minimum payoff, and maximizing sustainable benefits.

> condition of minimizing wrongs done to nonhumans in natural ecosystems.
>
> PW Taylor 1986, p.283.

In other words, if a human use of the environment is to be on an equitable footing with the interests of non-human nature, then the least damaging approach to that use must be taken, not just the most cost-efficient.[91]

This principle has been expressed in a number of different ways by different people. Connelly and Smith (1999) referred to "the moral considerability of living things", that "we should not be wasteful, wanton or destructive without good cause" (p.15). Maori principles also express this approach. As mentioned previously the concept of interpersonal responsibility, mana putaiao, expresses the belief that "we all have equal rights according to our creation, on this earth and we share the responsibility of looking after Papatuanuku, our Earthmother" (Jarman *et al*. 1996, p.94). With this comes the twin concept of mana tangata, personal integrity, described by Jarman *et al*. as ensuring that "our actions have significance and we do not entertain wanton and callous destruction, or depletion of resources simply because we have a short term 'need'" (p.94). The words tino rangatiratanga express this in a different way: "an obligation, a duty and a commitment to interact with our world in the most responsible and appropriate way we see fit, in order to fulfil our needs" (Jarman *et al*. 1996, p.94).

The approach of minimum wrong, or harm, was also recommended by Robert Goodland of the World Bank, according to Peter Montague (1996):

> To be ethical the project with the least environmental impacts should be selected.
>
> Goodland 1993, cited in Montague 1996.

The principle of minimum wrong, or harm, leads to the policy tools of 'alternatives' or 'substitutability'. It can be seen to operate, at least partially, in the Swedish government's policy on chemicals, in which their Ministry of the Environment (1998) promoted the principle of substitution as part of a policy for sustainable chemicals. The principle is spelled out thus:

> According to the Swedish Act on Chemical properties (SFS 1985, p 426) section *5 anyone handling or importing a chemical product must take such steps and otherwise observe such precautions as are needed to prevent*

[91] In fact, it is highly questionable whether pesticide use can be considered to be cost effective at all, if those costs incorporate all the externalities, as referred to in Chapter 1.

> *or minimize harm to human beings or to the environment. This includes avoiding chemical products for which less hazardous substitutes are available.*
>
> Bergkvist, Bernson, Jarl & Tornlund 1996, p.13.

The principle is implemented in the Swedish pesticide policy in the following manner (Bergkvist *et al*. 1996, p.13):[92]

- The substitution principle applies to pesticides, which are interchangeable and have the same of similar area of use.

- Pesticides can only be substituted if there is a significant difference in the risk to health or environment during use. To implement this approach, pesticides are divided into three zones on the basis of their inherent hazardous properties: red, orange and green zones. The red zone includes pesticides with particularly serious properties which exceed the cut-off criteria established in the government's *Principles for Identifying Unacceptable Pesticides* (Andersson, Gabring, Hammar & Melsäter 1992), and which are therefore rejected or phased out. The orange zone contains pesticides with clearly unwanted properties that exceed the guideline criteria.[93] The green zone contains approved pesticides. This zoning is used to establish significant difference—an application is rejected, or an authorization withdrawn if the comparative assessment shows the pesticides fall into different zones, but do the same job. Essentially, this means that a pesticide in the orange zone is rejected if there is an interchangeable one in the green zone.

Annika Nilsson (1997), in her PhD thesis on the sustainable way of handling chemicals, noted that "substitution is a measure well adapted to achieve its legitimate objective: to reduce risks caused by chemicals diffusely spread in the environment through products" (p.9). According to Bergkvist *et al*. (1996), this policy of substitution has been "an effective regulatory instrument" (p.13), although they did not explain what they meant by effective. Notably, however, the 1997 report from the Swedish Chemical Policy Committee, *Towards a Sustainable Chemical Policy*, did not propose any changes to this substitution approach (Wahlström 1999, p.52). But industry has not been happy with the

[92] The same approach has been used in the 1989 Massachusetts Toxic Use Reduction Act (TURA), which requires that companies using any of 900 listed industrial chemicals must go through a bi-yearly exercise of identifying alternatives that they could use instead of the specified chemicals. This and other measures in the Act have lead to a 20 percent reduction in the use of the chemicals over the period 1990-95 (Tickner 1999, p.177-8).

[93] The principles provide two sets of criteria: the cut-off criteria delineate unacceptable pesticides, and the guideline criteria delineate pesticides which have unwanted properties but which can be acceptable if it can be shown that the potential exposure to these is low (Andersson *et al*. 1992, p.11).

approach, and there have been unsuccessful attempts to weaken it, for example by removing the penalty for non-compliance (Wahlström 1999, p.66-7). Wahlström (1999) also made the important point that, whilst Sweden has often been ahead of other countries in regulating environmentally damaging chemicals, "so far, there is no substantiated evidence that the Swedish industry or the economy in general has suffered as a result" (p.59-60). Bergkvist (1999) reported that under this principle "a changeover from high risk substances to low risk ones, have generally not, on the long run, led to higher costs for the user" (p.4). None of the authors mentioned above have provided any information on how many pesticides had been rejected or had their authorization withdrawn as a result of this principle or to what extent harm to the environment from pesticides had been reduced.[94] Peter Bergkvist from the National Chemicals Inspectorate, in an email letter to the author on September 15 2000, stated that he could not give a figure on the number of cases when this principle has been used. He commented that "in many cases, the principle has not been the sole reason for withdrawal or restricting use" but has "tipped the balance" in favour of health or the environment.

The effectiveness of this principle in advancing the intrinsic interests of nature would be very dependent on the particular levels at which the criteria for the three zones are set. For example, if the cut-off point between the orange and green zones is too high, then most pesticides would pass the test and the principle would not function adequately as a principle of minimum harm. Hence, the principle alone is insufficient here: the political will to inflict minimum harm on non-human nature must be translated into meaningful criteria.[95] It is contended that a simple three-zone system may not be sufficient for this, and a more in-depth approach to hazard rating may be more appropriate to implement this principle. An example of a such a hazard rating system can be found in Appendix 2.

Furthermore, the principle of minimum wrong is only partially satisfied by the substitution of less harmful chemicals for more harmful chemicals. It would find greater expression in a policy that substitutes less harmful methods for more harmful pesticides, in which methods may be chemical or non-chemical. In other words the principle would apply not just to alternative pesticides, but to alternative pest, weed and disease management methods. Hence, a pesticide would not be registered if there exists a

[94] Wahlström (1999, p.55) stated that registration of the pesticides aldrin, dieldrin, endrin, parathion and its derivatives, dinoseb, and amitrole had all been cancelled on the basis of this principle, although these cancellations appear to have occurred more than twenty years ago, prior to the principle coming into effect. It is not known if there have been more recent cancellations on the basis of the principle.

[95] Here, again, is an instance that demonstrates the necessity for understanding the ecocentric ethic, and for absorbing it into thinking, attitudes and behaviour, else the policy will likely founder.

practical and effective methodology for controlling the offending organism(s) to the required level, with lesser harmful effects on the environment including human health, such methodology including chemical and non-chemical techniques. Further, a pesticide, even if registered for some uses, could not be used for other purposes for which a less harmful method exists. This concept is not a new one: Rachel Carson concluded in 1962 that "chemical pesticides should not be used where there are acceptable substitutes" (Norton 1991, p.122).

This concept is also incorporated in the Swedish pesticide policy, although not as part of the substitutability principle. Rather it finds expression in the benefit analysis part of their of risk-benefit assessment process. Here the approach that is taken is that the need for a pesticide must be demonstrated before it is accepted for registration, that need being in part dependent on the lack of existing pesticides, and on non-chemical methods (Bergkvist *et al*. 1996, p.12). The concept was expressed rather more strongly by the National Board of Agriculture in 1989:

> If equally effective, non-chemical methods are available for a certain control a pesticide will be banned for that control.
>
> Liden 1989, p.6.

The process also involves an "analysis of consequences" in which a prediction is made of the consequences of choosing certain alternatives (Bernson 1988, p.1061). It is not known how many pesticides have been 'banned' because of this approach. Again, it is contended that its effectiveness would depend on the political will of those responsible for its application. It would also depend on how widely the 'non-chemical methods' is interpreted. For example, if the pesticide is compared with an isolated non-chemical technique removed from the systems approach upon which its effectiveness might depend, then nothing would have been achieved. Frequently, and especially in organic production systems, control of pests, weeds and diseases is interconnected through a variety of management and other non-chemical techniques, all of which may depend on the proper functioning of each of the others for success. If the benefit analysis fails to incorporate this approach, the principle of minimum wrong to the intrinsic interest of non-human nature would not be adequately applied.

Thus, there are two ways in which this principle can be applied, both of which depend on political will in designing the system and in interpreting the information. The two ways are that of substitutability of less harmful methods for more harmful methods, or alternatively of a full risk-benefit analysis involving the comparison of the pesticide with other pesticides and with non-chemical techniques. It is contended that a full risk-

benefit analysis must involve a comparison of all known techniques for controlling the particular organism that threatens the productivity of the crop of concern, turning the process into what biologist Mary O'Brien (1999, 2000) referred to as 'alternatives assessment'. In this manner, it would be required that pesticides are compared, for example, with organic management techniques, and if the latter can achieve the required control with lesser adverse effects on the intrinsic values of nature than the particular pesticide, then that pesticide fails the test of minimum harm. Further, it is contended that the method most appropriate to an ecocentric ethic is that of substitutability, and it will be argued below that risk assessment, as such, is fundamentally at odds with ecocentrism.

Practical expression of both intrinsic values and ecological rationality in pesticide policy can also be found in other policy tools such as the internalisation of environmental costs through use of a hazard tax. Here, a variable tax is placed on pesticides, the tax being scaled commensurate with the level of inherent hazard the chemical poses to the environment and to human health. The tax then functions in two ways. Firstly, it acts to ensure that the price to users of the pesticide includes the potential damages to the environment and human health incurred by the manufacture and use of that pesticide, as briefly described in Chapter 1. Secondly, such a tax also acts to dissuade pesticide users from use of the more hazardous chemicals and directs them instead to least hazardous options. The tax can be based on the hazard rating system used to implement the principle of minimum wrong. The more comprehensive the system, the more likely it will be to reflect true environmental and human health costs. The reasons for choosing a hazard rather than a risk rating system, in this instance, will be provided in the section below on ecocentric ethics and risk assessment, and elaborated again in Chapter 6.

It is not the intention to analyze all policy tools available for a pesticide policy in this thesis, but rather to provide an ethical underpinning to the development of that policy. For it is of the utmost importance that a clear, coherent and consistent ethical direction be determined before policy tools are even considered. If that direction is not determined the policy may well end up heading off on a bearing that is tangential to that needed to achieve the real goals of the policy, as it is contended has been the experience with pesticide policy to date. Hence, the existence of some policy tools is merely noted here as being of use in an ethical pesticide policy. The exception to this has been the analysis of the principle of minimum harm, for the reason of demonstrating how an ecological approach to intrinsic valuation can be incorporated into pesticide policy because of a belief that it may not be possible to achieve this (e.g. Caldwell 1988). The

selection of appropriate policy tools then proceeds from the basis of this ethic, those tools selected always being consistent with the ecocentric ethic.[96]

Principle of minimum harm as an expression of the precautionary principle

The precautionary principle is commonly promoted these days as the solution to environmental problems, especially those resulting from hazardous chemicals, and therefore it is necessary to briefly review this principle and how it might relate to the principle of minimum harm, already established in the previous section. The precautionary principle implies that action should be taken against a substance causing environmental harm even before a definite casual link has been established, if there is threat of serious or irreversible harm (Connelly & Smith 1999, p.229-30). There are a number of definitions of the principle, differing largely in the weight that is given to the significance of the threat from the chemical. Connelly and Smith's version requires serious or irreversible harm, but that developed by the participants of the 1998 Wingspread Conference on Implementing the Precautionary principle took a stronger stand by omitting the word 'significant':

> When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.
>
> Raffensperger & Tickner 1999, p.8.

Before looking further at the implications of this principle, a brief look at its relationship to risk assessment is warranted. Despite the fact that the precautionary principle is often seen as the next approach beyond risk assessment, Gail Charnley (2000, p.9)[97] asserted that the precautionary approach was actually often used to guide decision-making *before* risk assessment became the tool of choice. As an example of this, she referred to the 1950's Delaney Clause which required the US Food and Drug Administration to ban outright food and colour additives that had been shown to produce tumours in humans and laboratory animals. Public interest groups supported this approach, but when they took a case to court to prove that pesticide residues were also covered by this clause and the court then required the US EPA to enforce this, huge pressure from the industrial

[96] It should be noted that the principle of minimum harm does not prevent the use of other policy tools such as sunsetting or banning particular groups of chemicals that may, for example be mutagenic, carcinogenic or endocrine disrupting. The Swedish chemicals policy operates on the basis of this principle, together with a requirement for the reverse burden of proof and minimum criteria for acceptable harm. The Swedish Chemical Policy Committee, for example, has set a target for zero persistent and bioaccumulating substances by 2007 (Wahlström 1999, p.67).

[97] Charnley, HealthRisk Strategies, Washington, D.C.

chemical lobbyists resulted in the passage of legislation that repealed the Delaney clause, and the precautionary approach, and replaced it with the risk management approach. According to other examples given by Charnley, the overturning of the precautionary approach by the risk-based approach actually occurred in 1980, in a court decision involving the petroleum industry. The 1980 *Benzene* decision overturned the precautionary basis of the 1976 *Ethyl* decision which had required the EPA to proceed with its plans to ban lead in gasoline even if the science was not strong enough to prove the case, by establishing the need to evaluate whether or not a risk is significant.[98]

Although the precautionary approach has become firmly routed in some European countries and in international treaties,[99] there has been much greater resistance to it in countries where risk assessment has become firmly entrenched as the 'sound science' approach to decision-making, including New Zealand. One of the reasons given by Carolyn Raffensperger and Joel Tickner (1999) for this situation is that risk assessment allows government regulators and agencies to defend their decisions "in the guise of objective, unbiased numbers, avoiding mention of the values implicit in decisions affecting public and environmental health" (p.2).[100] Risk assessment promotes a surety in science, but the precautionary approach exposes the uncertainty in science. Risk assessment operates on a basis of pollution control, but the precautionary approach operates on a basis of pollution prevention (Raffensperger & Ticker 1999, p.2).

Another reason Raffensperger & Tickner gave for the lack of implementation of the precautionary principle is the lack of any clear structure to integrate the precautionary principle into decision-making in the way that risk assessment has been (p.8). It has neither a commonly accepted definition nor a set of criteria to guide its implementation

[98] The *Benzene* decision is *Industrial Union Dept, AFL-CIO v. American Petroleum Inst* 448 US 607, 1980. The Ethyl decision is *Ethyl Corp v. EPA* 541 F.2d 1(DC Cir)(en banc), cert. denied, 426 US 941, 1976 (Charnley 2000, p.9).

[99] In particular Sweden, where the principle first found expression in the 1973 Act on Products Hazardous to Man or the Environment, and in Germany, where the 'Vorsorgeprinzip' or 'foresight' principle was established in water protection law in 1970; and internationally in the First International Convention on Protection of the North Sea, the 1992 Rio Declaration, the 1994 Maastricht Treaty on the European Union, the Barcelona Convention, the 1995 United Nations Agreement on the Conservation and Management of Straddling Stocks and Highly Migratory Fish Stocks, and the Global Climate Change Convention (Wahlström 1999, p.51-2; Raffensperger & Tickner 1999, p.4-5; Santillo, Johnston & Stringer 1999). In 1993 it was adopted as a fundamental guiding principle of EU environmental policy (Jordan & O'Riordan 1999, p.21). Also, more recently, it has been included in Article 10 of the Cartagena Protocol on Biosafety to the Convention on Biological Diversity, which was finalized and adopted in Montreal, 29 Jan 2000, at an extraordinary meeting of the Conference of the Parties to the United Nations Convention on Biological Diversity (www.biodiv.org/biosafe/Protocol/Background.html, accessed 14 December 2000).

[100] Raffensperger, Executive Director of the Science and Environmental Health Network, USA; Tickner, Doctoral candidate at the University of Massachusetts, Lowell.

(Jordan & O'Riordan 1999, p.22). Thus, its vagueness allows for the expression of a principle that the public accept, but "fails to bind anyone to anything" (Jordan & O'Riordan 1999, p.22). This is certainly a problem with some New Zealand legislation such as the HSNO Act, which contains a reference to the precautionary approach, but only in terms of the requirement "to take into account the need for caution in managing adverse effects where there is scientific and technical uncertainty about those effects" (section 7). After that, it is business as usual with the risk assessment approach. The Order-in-council which established the methodology for the implementation of this principle, amongst other aspects of the legislation, simply stated:

> 24. The Authority, its chief executive, its staff, and any appointed expert must use recognised risk identification, assessment, evaluation, and management techniques.
>
> 25. (1) When evaluating risks, the Authority must begin with a consideration of the scientific evidence relating to the application, and take into account the degree of uncertainty attaching to that evidence.
>
> HSNO (Methodology) Order 1998, cited in ERMA 1998, p.13.

Andrew Jordan and Timothy O'Riordan also commented that the precautionary principle lacks:

> . . . coherence other than that it is captured by the spirit that is challenging the authority of science, the hegemony of cost-benefit analysis, the powerlessness of victims of environmental abuse, and the unimplemented ethics of intrinsic natural rights and intergenerational equity.
>
> Jordan & O'Riordan 1991, p.16.[101]

Thus, the precautionary principle, whilst being a "powerful and progressive approach" (Jordan & O'Riordan 1999, p.32), runs the risk of being blunted by assimilation into modern political language through an "epistemological ambiguous pathway" (p.17), with its variations in interpretations and lack of stability of expression—in other words the same fate that has befallen the concept of sustainability. The principle of minimum

[101] Jordan, Centre for Social & Economic Research on the Global Environment, University of East Anglia, Norwich and University College London; O'Riordan, Professor of Environmental Sciences, University of East Anglia.

harm, it is contended, does not present this problem, for it provides a very precise structural approach to the implementation of pesticide policy, an approach which has proven to be effective in Sweden over a number of years. For this reason, attention has been placed, in this thesis, on the principle of minimum harm rather than on the precautionary principle, even though each can be seen to be an expression of the other.

There is another reason, too, for the preference for the principle of minimum harm: the precautionary approaches pivots on science and its lack of certainty, whereas the principle of minimum harm pivots on a respect for nature and the ethical underpinning of intrinsic rights and values. Science is no longer centre stage. It takes its place as a knowledge system that can inform decisions, but not the sole focus of those decisions. This is an important point, for it will be argued in the next chapter that there are other systems of knowledge besides science that are equally deserving of admission to the policy process, and especially in the area of deciding on minimum harm. This is not to say that the precautionary approach does not incorporate other systems of knowledge besides science, or that it does not incorporate the intrinsic values of nature, but simply to point to a different emphasis. One advantage of this approach is that, whilst the precautionary approach "does not determine how a noninstrumental respect for nature should be incorporated into decision making" (Jordan & O'Riordan 1999, p.17), that is precisely what the principle of minimum harm does achieve.

It should be evident by now that the implementation of the ethic of minimum harm is an excellent expression of the precautionary principle, although they start from different positions. Bo Wahlström (1999, p.52) drew a link between the precautionary approach and the principle of minimum harm in referring to the way in which the former, which was incorporated in the 1973 Swedish Act on Products Hazardous to Man and The Environment, was then reformulated as the latter in the 1985 Act on Chemical Products.[102] The second Act, as already discussed in the preceding section, requires that chemical products for which there are less harmful alternatives must be avoided. Wahlström asserted that the precautionary principle "still stands as the fundamental precept of Swedish chemicals management and control" (p.53). Given the significant levels of uncertainty relating to the effects of ongoing low dose exposure of mixtures of pesticides on humans, and on the environment, it is contended that the only way in which the precautionary principle can be adequately applied to pesticides is through minimizing exposure, by implementation of the principle of minimum harm.

[102] Wahlström, international advisor for the Swedish Chemical Inspectorate.

One further aspect of the precautionary approach needs to be referred to with respect to the principle of minimum harm. It has been asserted by a number of writers (e.g. Ashford 1999; Jordan & O'Riordan 1999; Tickner 1999; Wahlström 1999) that the precautionary approach implies a shifting of the burden of proof, so that the onus is on the producer of a product to show no harm, rather than the current situation in which a regulator needs to show the pesticide causes harm before removing it from the market. It is contended that this is also, logically, an important facet of the principle of minimum harm: if the intention is truly to minimise harm, then it seems a necessary condition to give the benefit of the doubt to nature rather than the chemical in assuming the harm. In support of this position, it is important to note that the preamble of the 1973 Swedish Act on Chemical Products Hazardous to Man or the Environment stated that a scientifically-based suspicion of risk was sufficient grounds for measures to be taken against a chemical (Wahlström 1999, p.35), remembering that this Act then was replaced with the stronger Act containing the substitution principle. In other words, it is fair to say that this linkage was made by Swedish chemical legislation.

5.3.4 Ecocentric ethics and risk assessment

It is contended that ecocentric rationality is at odds with toxicology, and an ecocentric ethic is at odds with risk assessment.[103] As has already been described in detail, ecocentric rationality eschews the reduction of the whole to separate parts, exactly the basis for toxicology. If an ecocentric ethic is adopted, toxicological risk assessment is no longer appropriate as the main decision-making mechanism of pesticide policy. That does not mean that toxicology has no place, for it is contended that it would still have a function in comparative hazard description, recognizing the limited nature of the hazards described and the limitations of the mechanistic approach. Rather, it means that the assessment of risks and benefits on the basis of toxicology is no longer appropriate. Although toxicology is limited in its ability to accurately portray the real effects of pesticides, as long as those limitations are clearly defined and the value bias made explicit it is currently the best available method for providing information on the relative hazards of different pesticides.[104] The real problem lies in the assumption that toxicology can provide an account of actual effect and hence assurance of safety. It has been adequately demonstrated in Chapters 4, 5, and 6 that it cannot do this. Hence, the assessment of risk on the basis of toxicology becomes problematic. Thus, it is not so

[103] The term toxicology is used from here on to mean both that which relates to human health and that which relates to the environment, i.e. ecotoxicology.
[104] This comment relates to pesticides that are new on the market; for those that have been in use for many years, community and user experience may provide a better source of information.

much the toxicology that is rejected but rather the use of that toxicology to establish risk and to make decisions about safety on that basis.

In addition to the problem of the accuracy of the risk derived from the mechanistic science of toxicology, there is an added problem of using the derived risk in a risk-benefit balancing exercise. For an ecocentric ethic "resets the parameters for weighing up the goods" according to Bosslemann (1995, p.160). Despite a recognition that there needs to be more ecology in ecotoxicology (Jepson 1993), and a recognition that "prediction [of ecological risk] is difficult particularly as far as indirectly induced changes are concerned" (Mathes & Winter 1993, p.1679), attempts to remedy the situation using the traditional risk-benefit approach (e.g. Jepson 1993; Mathes & Winter 1993) will fail under an ecocentric ethic. With adoption of this ethic, the valuation of non-human interests must be placed alongside that of human interest.

What is of essential importance here is that the legally allowable ecological limits for pesticide contamination, such as have been derived under regulations attached to the HSNO Act, are not protective of intrinsic values. Similarly, setting environmental standards (e.g. Barnett & O'Hagan 1997), or using ecosystem threshold criteria as a basis for regulating pollution (e.g. Schaeffer & Cox 1992), or operating on the basis of critical loading, does not consider or protect intrinsic values and hence does not apply an ecocentric approach. The mechanistic nature of such methods and their consequent failure under an ecocentric ethic is displayed by the definition of critical loading as:

> . . . a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to prior knowledge.
>
> OECD 1994, p.18.

This definition infers an ethic of 'do as much damage to the environment as it can, hopefully, sustain', and hence is a complete denial of the ethic of intrinsic values and of ecological rationality, given the current state of scientific understanding of the effects of ongoing low dose exposure of the environment to chemical mixtures. An ecocentric ethic, on the other hand, takes the approach of minimising the damage to the environment in the process of extracting the resources that are necessary for survival. It does not premise any level of harm as acceptable.

The risk assessment approach to ecological values is one in which a chemical should be used if it passes the test of effect on particular ecological end points arrived at by a reductionist methodology. It carries with it the anthropocentric notion of extracting as

much resource from the environment as is possible within the limits of 'acceptable' damage. Chemicals are assumed to be needed and therefore, rationally, should be used unless they can be proven to have 'unacceptable' ill effect.

In contrast, the ecocentric approach would firstly seek to minimise any adverse effect on the complex interrelatedness of the ecosystem's web of life. The point of approach is that the maintenance of the integrity of the ecosystem is required and non-human nature has intrinsic interests that are of merit equal to those of humans. Chemicals are *not* assumed to be needed. The point of permission of chemical use comes if it can be proven to be necessary and the effect on both human and non-human nature can be deemed acceptable on the basis of a partnership approach, that is a partnership between human and non-human nature. The proof of necessity for a pesticide in an ecocentric system lies within the approach of using the pest management systems that have the least adverse effect on the ecosystem and its intrinsic values, including those of individual non-'pest' organisms. The proof of effect of a chemical would require that synergistic and additive effects of combinations of chemicals in the environment be fully assessed before release of a pesticide.

A new way of looking at risk is thus required under the ecocentric ethic. Of prime importance is the reversal of the burden of proof: "whoever creates risks (through projects, planning or products) carriers the burden of proof that the risks can be justified according to the ethical measure of nature's intrinsic value" (Bosselmann 1995, p.247). Given that current scientific methods cannot determine that a mixture of chemical pesticides will not adversely effect non-human nature, other than the particular insects, weeds and diseases for which control is desired, then it becomes unethical to 'spray and pray', to use the chemicals in ignorance of actual effects. A new way of looking at property rights is also entailed, involving an ecological obligation attaching to property. This means that if a person wants to assert their anthropocentrically-derived individual 'freedom' to spray pesticides on their private property, and consequently to drift them, they must address not only the social justice effect on other people, but also the ecological justice effect on the intrinsic values and interests of non-human nature.

Thus, scientific rationality is not sufficient in itself for decision-making under an ecocentric ethic. Its methodologies can be used to inform decisions by provision of information about specific effects of specific chemicals on specific aspects of the environment. But it cannot provide assurances about the total effect of a chemical interacting with other chemicals on the interconnectedness of the various elements of the ecosystem web. Nor can it provide for effects on intrinsic values of nature, for these

remain outside of the realms of quantification and mathematical modelling. They are in effect, like the value of a human (Bosselmann 1995, p.261), indeterminable. Therefore, decisions about the effects of pesticides on nature become irrational if they are made solely on the basis of scientific and economic parameters. A rational decision about pesticides must lie beyond the realms of science, incorporating an ethical approach in which both human and non-human values are considered within an overall social approach that pays equal respect to all life forms. Therefore, other forms of knowledge must be validated within the policy making process. It follows from this that people other than scientific experts must be involved in providing and judging that knowledge. The issues of who should make the policy decisions, and on the basis of what knowledge, become of vital importance to pesticide policy development, and these two subjects form the basis of the last two chapters.

5.3.5 Is a pesticide policy consistent with an ecocentric ethic?

Before leaving the subject of an ecocentric ethic in pesticide policy, there is a question to be answered: should there even be a pesticide policy under an ecocentric approach? The answer is probably no, there should not be. As Roderick Nash (1989) noted, the very term 'pesticide' is an anthropocentrism, for "a creature is a 'pest' only from the human perspective" (p.79).[105] Hence, Rachel Carson's use of the term biocides, as killers of life, instead of pesticides. If, as is the case, pesticides are designed to kill life, the two concepts appear incompatible. It is true that most pesticides have no place in a farming system based on ecological principles. However, pesticides *are* used and will continue to be used to a greater or lesser extent, at least in the medium term. As ecological rationality is brought to bear on agriculture, their use and inherent hazard should diminish. Pragmatically therefore, there is a need for a policy relating to pesticides at least in the medium term.

Yet a pesticide policy as such exhibits the same reductionism and mechanistic separation of the agri-ecosystem into constituent parts that has been criticised in this thesis. Under an ecological ethic everything can be seen to be interrelated, so where to delineate the edges of a policy becomes a conundrum. If not a pesticide policy, should there be an agri-ecosystem policy? Or an agricultural policy? Or a food and fibre policy? Or a land management policy? Or a rural society policy? And so on. For not only are the pests, weeds and disease intimately related to other aspects of the agri-ecosystem such as fertility, but they are also related to labour input, which is in turn related to a number of other societal issues. Pragmatically, a line needs to be drawn somewhere. Where that

[105] Nash credited Rachel Carson (1965) with this view.

line should be drawn is not a truth, but depends upon manageability of resources and existing structures, always bearing in mind the primary concept of interrelatedness. In the first instance a small country such as New Zealand may be able to achieve broader policy areas than a larger more complex country, such as India or the USA. In the second instance, it is contended that existing agri-ecosystem structures which are heavily dependent on pesticides, together with legislation that establish regulatory authorities, requires that at least in the medium term, there be a pesticide policy. The challenge is to adapt that policy to reflect an ecocentric ethic and to gradually change the wider policy structure so that pesticide policy might be integrated within a wider land management and rural reconstruction policy approach.

Conclusion

This chapter began with an exploration of the concepts and value systems underlying modern science and how they came to shape the current technological worldview, the rationality that is claimed by that worldview, and hence pesticide policy. It has been argued by other writers, at a general level (e.g. P Taylor 1998b), that the anthropocentric approach to humanity's relationship with nature has directly contributed to an environmental crisis, and that the anthropocentric approach is reflected and affirmed by current environmental law. Chapters 3 and 4 teased out the inadequacies of toxicology and this chapter contributed an analysis of the inadequacies of ecotoxicology, principally because of its failure to operate from a basis of ecological rationality. The mechanistic approach has been shown to fail and to be superseded as a scientific philosophy in other areas of scientific endeavour, such as physics. The need to shift from an anthropocentric ethic to an ecocentric ethic has been recognised by many for a long time, and is now well established in philosophical, legal, ethical and scientific writings. Yet, for all the erudite exchanges on ecocentric ethics, and the gradually increasing recognition of the necessity of a paradigm shift to such an ethic (Bosselmann 1995, p.21,101), pesticide policy generally is still rooted deeply in an anthropocentric ethic, and even more so in the mechanistic-mathematical science model that has been challenged so dramatically by postmodern scientific developments in other areas.

Whilst the RMA makes limited acknowledgement of intrinsic values of nature, nothing in toxicological risk assessment recognises those values. Hence, pesticide policy has not kept pace with the (tentative) legal recognition of an ecocentric ethic. Although the concept of ecological interdependence is now well understood by science and finds

space in many international agreements, declarations and resolutions (OECD 1994, p.5), it has been slow to find its way, in a practical manner, into pesticide policies.

Therefore, a new approach has been described and in the process the foundations have been laid for ethical development of pesticide policy. It has been argued that the rational and ethical approach is one that is based on an ecocentric ethic, which recognises the interconnectedness of all living organisms within the complex web of the ecosystem, and which recognises the intrinsic rights of non-human nature in a partnership approach that places humans and non-human nature on an equal footing. Within the partnership approach, humanity continues to manage agri-ecosystems in a manner that provides for its needs, but in a manner that also minimizes harm to the intrinsic interests of non-human nature. Such an approach is epitomized by the non-interventionist methods of Fukuoka's natural farming, but currently finds more pragmatic application, for attitudinal reasons, in organic farming systems. It was demonstrated that, contrary to appearances, pesticide policy still has a place under an ecocentric approach to public policy, at least in the medium term.

Finally, it has been argued that there is a fundamental problem with risk assessment as a pesticide policy approach, in that it is inconsistent with an ecocentric ethic. Whilst toxicology and ecotoxicology are reductionist and mechanistic, they still have a role to play in comparative hazard analysis, as long as their limitations in depicting real effects of pesticides are recognized. The problem lies with the assumption of risk assessment as an accurate portrayal of real effect and the consequent weighting of risk and benefits where only narrowly defined benefits to humans are included. The incompatibility of the current risk-benefit process with an ecocentric ethic requires that different processes are needed for decision-making, and knowledge systems other than mechanistic science should inform that process. The issue of pesticides in a policy development context poses the need to draw together the threads of social justice and 'ecological wisdom', a project hinted at by Barbour (1973, p.11) and Sessions (1991, p.148), in a manner that Naess foreshadowed in his writings on deep ecology in his references to egalitarianism, classlessness and democracy (Naess 1972, p.120; Glasser 1996, p.166). The ecocentric ethic applies not just to humanity's relationship with non-human nature, but also to its relationships within humanity. These topics will be discussed in the next two chapters as an ethical policy process is fleshed out in a manner that will also better reflect the assessment of risk by the public.

Among the many environmental philosophers and writers who have been mentioned in this chapter, and many others have been omitted for reasons of space, one deserves

special mention—and that is Rachel Carson. For Carson, not only popularised environmental concerns with her book *Silent Spring,* which was serialized in *The New Yorker* (Nash 1989, p.81), but also her medium was pesticides. Using the ravages caused by DDT to nature, she acquainted the world, and particularly Americans, with the concept that "it was right to include all forms of life, and even the ecosystem as a whole, in humankind's moral community" (Nash 1989, p.82). Her closing comments displayed her abhorrence of the arrogance of mankind:

> The 'control of nature' is a phrase conceived in arrogance, born of the Neanderthal age of biology and philosophy, when it was supposed that nature exists for the convenience of man. The concepts and practices of applied entomology for the most part date from that Stone Age of science. It is our alarming misfortune that so primitive a science has armed itself with the most modern and terrible weapons, and that in turning them against the insects it has also turned them against the earth.
>
> Carson 1965, p.257.

The relationship between ecological rationality and the ecocentric ethic

The linking of science with ethics may be considered problematic, especially by those from positivist science disciplines, who have striven to mark out for science an epistemological territory that is untrammelled by questions of a philosophical nature.[106] Thus, it can be expected that the linking of ecological rationality with an ecocentric ethic in this thesis may not go unchallenged.

It is contended, however, that such a challenge cannot be substantiated, for a number of reasons. It has been clearly demonstrated throughout this chapter that the mechanistic science that is currently used for pesticide policy rests on a technological rationality, which in turn rests on a number of assumed social values that together comprise what is known as the anthropocentric ethic. That the challenge could be contemplated at all, is an expression of the hidden nature of the ethic that underlies mechanistic science. The ethic is there: it is simply not spoken. The challenge, should it appear, would rest on the Cartesian view that anything that is not scientific lies separate from science. But science is not separate from ethics, especially that science which relates to pesticides. This view is supported by Robin Eckersley:

[106] Positivist philosophy takes a similar approach, maintaining a separation from things of a scientific nature.

> Ethics and science can no longer be separated: both are relevant to how nature should be treated.
>
> Eckersley 1999, p.38.

Additionally, it has been established in Chapters 3, 4 and 5 that the assessment of risk from pesticides rests on a substantial number of value judgements. Those judgements are made from a position of technological rationality, but they are based on an ethical approach to life. They are inextricably linked.

Ecological rationality demands that all parts of nature are interconnected: it cannot therefore entertain the notion that two such complex systems of human endeavour such as science and philosophy are disconnected from each other. Thus ecological rationality itself dispels the notion of epistemological dualism. As Plumwood pointed out:

> We had better not understand ecological rationality . . . in a rationalist way that links it to the doctrine of the separateness and supremacy of reason in human life. . . . A concept of ecological rationality should not repeat these mistakes by tying itself to traditional concepts of reason or by assuming that rationality has a monopoly of the capacities we need to mobilise for survival.
>
> Plumwood 1998, p.563.

Ecological rationality demands that humanity recognise that all parts of nature are interconnected and that what affects one part can be transmitted throughout the whole system in varying degrees. It is not logical to assume that humanity can continue with the anthropocentric approach of domination of nature once it grasps the essential nature of ecological rationality. For to grasp that essential reality is to understand that mechanistic science fails to provide the information required for humanity to continue dominating nature without, in the process, destroying the very means for its own survival. Hence, if for no other reason than species survival, humanity is forced by ecological rationality to develop a different relationship with nature, one that understands that humanity cannot exert ultimate control of nature, one that respects nature, one that allows humanity to live in partnership with nature. That is the understanding and relationship that an ecocentric ethic provides. Hence, the sciences of ecology and ecotoxicology, if they are based on ecological rationality, cannot avoid an ecocentric ethic. Ecocentrism is essentially a dialectic of humanity in relationship with its environment: it rejects the notion that humans can pursue their own agenda of anthropocentrism without reference to the environment, without reference to ecological rationality. The ecocentric ethic is based on scientific evidence regarding the nature of living systems.

Finally, regardless of the epistemological relationship between science and ethics, ethical pesticide policy, like other public policy, must strive to bring together all realms of knowledge that effect the decisions to be made. It does not have the option of omitting ethical considerations. The argument that has been presented in this thesis is, firstly for the acknowledgement that ethical systems already underpin pesticide policy, and secondly for the replacement of the existing anthropocentric ethic for the ecocentric ethic. As previously mentioned the ecocentric ethic is primarily about the relationship between humanity and nature, and that is precisely also the relationship that lies at the heart of pesticide use and pesticide policy.

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Chapter 6 Beyond Positivist Science

> We must draw our standards from the natural world. We must honor with the humility of the wise the bonds of that natural world and the mystery which lies beyond them, admitting that there is something in the order of being which evidently exceeds all our competence.
>
> Václav Havel, cited by Korten 1998, p.119.[1]

Introduction

The process of developing ethical pesticide policy was begun in the last chapter with the determination, firstly that such a policy must state the ethic upon which it is based, and secondly that the ecocentric ethic is rationally and ethically superior to a mechanistic anthropocentric ethic. All else flows from the underpinning ethic.

Having determined the basic ethic on which policy development must rest, two other major areas were identified in the previous chapter as meriting close consideration—that of which knowledge systems should be admitted, the subject of this chapter, and that of who should be involved in making the policy decisions, the subject of the next chapter. Before embarking on these final stages, it is worthwhile briefly recapping the findings of the previous chapters as they contribute significantly to these remaining areas.

Chapter 1 provided the contextual background for this process, drawing attention to the role of public values in policy (Considine 1994, p.3). No matter how scientific or technical the subject matter appears to be, at a national policy level the choices to be made regarding pesticides are social choices rather than scientific choices, for they involve a variety of social issues and values, rights and entitlements. Whereas the consequences of an individual's risk decision are borne by that individual, the consequences of a public risk decision are borne by the whole of society. Thus, society as a whole must be reflected in the policy process. The process of legitimating societal values with respect to pesticides began with the re-defining of the terms 'scientific assessment' and 'public perception' as 'technical assessment' and 'lay assessment', thus reducing the bias that creeps into public policy through the injudicious use of language.

Chapter 2 sought to identify important aspects of social rationality that underlie lay assessment, how it differs from assessment based on scientific rationality, and to demonstrate the level of public concern about pesticides. It revealed marked differences

[1] Korten sourced Havel's quote from Benyus (1997, p.1).

in assessment by males and females. It drew attention to the reasons for the public loss of trust in technical assessment, and the influence of differing worldviews on assessment. It also revealed that legitimization of social rationality by itself is not sufficient, in the face of a lingering perception that technical assessment provides accurate descriptions of actual risk.

Consequently, Chapter 3 analyzed the process involved in the technical assessment of pesticides. It was found to suffer from lack of accurate data, to be based on very few concrete facts, and hence to be subject to significant uncertainty, subjective evaluations and value system bias. Furthermore, the technical process fails to acknowledge the reality of human experience, which is that of constant exposure to low doses of mixtures of chemicals, as was discussed in Chapter 4. Such exposure may lead to the syndrome of multiple chemical sensitivity. The traditional technical approach to pesticide toxicology does not capture these problems.

This exposure of the failures of technical assessment lead to the analysis, in Chapter 5, of the rationality that underlies that assessment, of the particular worldview of mechanism that gave rise to modern science and which still determines the outcomes of toxicological risk assessment, even though other branches of science have moved beyond mechanism in their understanding of nature. It was argued that an ecocentric paradigm provides a more rational and ethical approach to pesticide policy than the currently dominant approach of anthropocentrism and mechanism. It was further argued that this ethic best finds expression in a partnership approach towards nature, which acknowledges humanity's need to maintain a productive agri-ecosystem in order to sustain life, and in which the intrinsic values of nature are recognized through the application of the principle of minimum harm. The principle of minimum harm requires proof that the pesticide is needed, and that preference is given to the least harmful methods of pest, weed and disease management, whether these are chemical or non-chemical.

Immediately, it can be seen that the whole basis for determining pesticide policy has shifted away from the bare technical analysis of risk of a single chemical on the basis of mechanistic assumptions and modelling and towards an approach which incorporates entirely different values and knowledge requirements. The new approach must incorporate societal views and values and, at the same time, be grounded in the rationality and ethics of an ecocentric approach.

Because the underlying ecocentric principle requires that pest management be carried out in a manner that causes least damage to the environment, including humans, there

are essentially two very different subsets of knowledge that must be admitted to the policy process. One identifies all the various methods of pest management that are available, including pesticide and non-pesticide methods, and the other determines the damage these are likely to cause. As this second aspect is the only one that is involved in the standard risk assessment approach, it will be used to illustrate the wisdom of admitting non-scientific knowledge to the policy process. Later in this chapter, the admission of knowledge about non-pesticide management methods will be briefly addressed. First, however, it is necessary to remove mechanistic science from its elitist position as the provider of all knowledge:

> The claim of science is that it differs fundamentally from other belief systems in that it rests demonstrably on reason alone. But the claim must be modified in light of what historians have to say about scientists' resistance to scientific ideas and their penchant for seeing the world through the prism of their own theories. . . .
>
> To say that the process of science includes nonrational elements is not to say that rationality is absent. Science is both logical and illogical, rational and irrational, open-minded and dogmatic. The exact proportions of each ingredient vary from one discipline to another, depending on time, cause, and place. The degree of nonrational elements in scientific thinking is doubtless less than in other belief systems, but perhaps not significantly so. The burden of proof must lie with those who make special claims for science and scientists.
>
> Broad & Wade 1982, p.140-1, cited in Moore 1999, p.80.

6.1 Rejection of science as sole arbiter of knowledge

The first stage in legitimating non-scientific knowledge in the policy process is to challenge the elitist position accorded mechanistic science. Objectivity and rationality are the two epistemological foundations of mechanistic science. They are the terms used to describe toxicological risk assessment, terms that are at once used to legitimate the mechanistic knowledge system it relies on and at the same time to exclude all others systems of knowledge. These two terms stand in the way of the inclusion of non-scientific knowledge in pesticide policy, thus it becomes necessary to challenge the manner in which they are used. To an extent this challenge has already been made, in that the analysis of technical risk assessments in Chapter 3 revealed involvement of value systems, and in that Chapter 5 demonstrated mechanistic rationality to be fundamentally flawed as a descriptor of ecological reality. However, it is contended that

the issue of objectivity needs revisiting at this point because of the overwhelming emphasis that is placed upon it in toxicology-based pesticide policy.

6.1.1 Objectivity challenged

In determining that the outcomes of both scientific and lay pesticide risk assessments are significantly influenced by values, the risk is run of being labelled a cultural relativist. The removal of the patina of objectivity, on the basis of the involvement of value systems in the subjective areas of the technical process, at once also removes the right to sole arbiter of rationality that has been claimed by those whom Shrader-Frechette referred to as "naive positivists" (1991, p.9). Shrader-Frechette concluded, after her detailed and persuasive analysis of the arguments of both ends of the spectrum of views on the rationality of science, the cultural relativists and the naive positivists, that neither are correct in their beliefs and that there is a middle way which permits "rational, objective, democratic risk assessment" to be carried out (1991, p.29).[2] She referred to this as scientific proceduralism. It is not the intention to analyse her approach in detail here. However, there is merit in scrutinizing her belief in the ability to achieve risk assessment that is objective.

Chapter 2 provided the basis for a claim that risk assessment by lay people is made rationally on the basis of their own value systems, and therefore is just as rational as those of the technical assessors, who also assess risks on the basis of their value systems. To be rational involves assessing risk in a manner that is cogent with one's value system. To do otherwise is irrational. That being so, it therefore becomes impossible to achieve objectivity in assessing risk, as well as rationality, for the two are mutually exclusive. Further, since a person's value system cannot be simply suspended, it is contended that objectivity can never be achieved. Objectivity is defined by the Oxford Dictionary as "the ability to present or view facts uncoloured by feelings, opinions, or personal bias" (Brown 1993, p.1965). With the best of intentions, a person cannot simply put aside all her/his training, cultural values, life experience, family upbringing, spiritual views, hopes and aspirations: to do so is not in the nature of humanity. Therefore, total objectivity cannot be achieved in pesticide policy decisions, or in technical risk assessment. It can be striven for to a greater or lesser degree. The best that can be hoped for is the greatest degree of objectivity possible. In this point, therefore, Shrader-

[2] In which cultural relativists such as Mary Douglas and Aaron Wildavsky argue that all risk assessment is the outcome of social determinants; and naive positivists such as Chauncey Starr and Christopher Whipple argue that technical risk assessment is objective and rational—according to Shrader-Frechette (1991, p.8,9,38).

Frechette's belief in an objective assessment of risks is rejected. However, it should be acknowledged that her view of objectivity appears to be different from that of the Oxford Dictionary. For she described scientific objectivity as:

> . . . testing the predictive and explanatory power of our risk theories and by subjecting risk evaluations to intelligent debate, criticism, and amendment by the scientific community and laypeople likely to be affected by the risk.
>
> Shrader-Frechette 1991, p.47.

This process does not necessarily exclude the involvement of 'feelings and opinions'. Shrader-Frechette defended her view of objectivity by recourse to Israel Scheffler, to whom she attributed the view that scientific objectivity requires simply "the possibility of intelligible debate over the merits of rival paradigms" (Scheffler 1972, p.369, cited in Shrader-Frechette 1991, p.52). Philosopher Mary Midgley (1992) defined the everyday view of objectivity in science as keeping "irrelevant biases" out of it, as "not letting one's political views interfere with one's reasoning" (p.47). As has been demonstrated in Chapters 3, 4, and 5, this is not what happens with toxicological risk assessment, in which values are everywhere present. Fischhoff *et al.* observed that objectivity about values is not possible and hence:

> The search for an "objective method" [of defining acceptable risk] is doomed to failure and may obscure the value-laden assumptions that will inevitably be made.
>
> Fischhoff *et al*. 1981, p.xii.

Even the National Academy of Sciences in the USA acknowledged that "science is not necessarily neutral and objective in its way of framing problems [or] in its choice of assumptions" (NAS 1996, cited in Charnley 2000, p.10).

It is contended that, rather than labour the issue of objectivity and what it may represent on a pragmatic level, it might be more appropriate to acknowledge that, at least with respect to pesticide policy, nobody has a completely objective viewpoint, and that it may better serve democracy to proceed on that basis. Shrader-Frechette (1991, p.46-52) made it quite clear that her view of objectivity did not embrace that of the cultural relativists, who "make too strict a demand on scientific objectivity by requiring value-free confirmability alone" (p.49). Yet that view of objectivity as being value-free is precisely the one that is espoused by proponents of 'sound science decision-making' and is used as the reason for rejecting non-scientific information. The use of the term 'objectivity' is an example of the power of policy language, much as is the allocation of the terms

'assessment' and 'perception'. The charge of a 'lack of objectivity' is frequently levelled against those who oppose the 'objectivity' of the risk assessors, in order to discredit the former's views. Clearly, as has been demonstrated, this charge cannot be substantiated as such. MacIntyre *et al.*, in their in-depth analysis of the issues surrounding pesticides in New Zealand, had this to say about objectivity:

> The asserted "facts" are not objective science at all; they are disguised social and economic preferences, derived mostly from peoples' pre-existing values, educational backgrounds, interpretations of modern chemical technology, degrees of financial dependence upon industry, and perceptions of who wins and who loses, etc. To the extent that claims are based on science, it is the pseudo-science of policy advocacy: facts are used selectively and information is distorted so as to give hidden statements of value-preference all of the persuasive weight and political legitimacy that our society attaches to rational science.
>
> MacIntyre *et al.* 1989, p.12.

Thus objectivity is rejected as a basis for pesticide policy-making. However, the rationality and democracy of Shrader-Frechette's approach are not rejected, for both become possible, the one contingent on the other, and both contingent on an understanding of the impossible nature of objectivity. If it is accepted that rational decision-making derives from making assessments and decisions in a manner that is cogent with one's value system, then it becomes easier to envisage how democracy can be achieved—by recognizing those value systems, and by empowering them equally. However, it must be remembered that mechanism has been rejected, at least with respect to determining the safety of pesticides in the environment, and that the rationality of mechanistic ecotoxicological risk assessment, and by extension toxicological risk assessment, gives way to ecological rationality. At the same time, an ecocentric ethic was posited as more consistent with this rationality than an anthropocentric ethic. Thus, the values expressed by both lay and technical assessment processes must be accommodated within ecological rationality and an ecocentric ethic. If this is to occur, then it is clear that knowledge other than that derived by mechanistic toxicology must be admitted to the policy process.

6.1.2 Positivism exposed

In arguing, in Chapter 5, that an ecocentric approach to policy development is rationally and ethically the most appropriate approach, two common threads of ecocentrism were analyzed and applied to pesticide policy. There is, however, another thread that can be

found in many,[3] but not all, discourses on ecological ethics—that of the need for a new approach to knowledge. Concomitantly with the gradual replacement of the anthropocentric ethic by the ecocentric ethic comes a broadening of understanding of knowledge, science, facts, and truth. Additionally, the recognition of the need for a new approach to knowledge appears in the writings of critics of modern science who are not specifically espousing an ecocentric ethic.[4]

Many of these critiques take the course of advocating a new form of science. Marcuse argued the need for a science that would overcome the limitations of instrumental rationality imposed by the mechanistic model (Eckersley 1992, p.104-5). Sociologist Bill Devall (1980) and philosopher George Sessions (1991), both proponents of deep ecology, argued that mechanistic science must be replaced by a new non-anthropocentric science. Capra argued for a science based on a systems approach in which the Cartesian belief in the certainty of scientific knowledge is replaced with an understanding of the limitations of scientific concepts, and the approximate nature of information flowing from them (1998a, p.338).

Feminist epistemologies have challenged the right of science to be the sole arbiters of how knowledge can be validated and how truth can be arrived at, in particular the belief that the mind alone and particularly the "empirical eye" can know nature (Merchant 1996, p.xix). Merchant noted that it is "scientists in power [who] have set the debate and determine[d] the concepts that define reality" (1996, p.62), and argued that the tools of scientific discourse (mathematics, observation and experimentation) "are permeated by the principle of domination" (1996, p.62) arising from its roots in Cartesian dualism, that is the separation of the active, thinking, controlling subject and the passive, external controlled object. The origins of that cultural ideology have already been discussed in the previous chapter. Claiming such privileged access to reality allows a social group to exert its power to control knowledge.

In particular, it is the positivist approach of modern science that has been widely criticised across many disciplines.[5] Positivism admits only valid, verifiable, factual, and

[3] For example Bosselmann 1995, Devall 1980, Sessions 1991, Merchant 1996.

[4] For example Funtowicz & Ravetz 1992, Midgley 1992, Moore 1999.

[5] The Positivist movement was active in the 1800s, the term having been coined by the Frenchman Auguste Comte to describe a particular scientific philosophy, that of empiricism based on inductive logic—essentially the use of prior observations to predict future outcomes (Moore 1999, p.68). Logical Positivism was developed by the Vienna circle in the 1920s and 1930s and came to dominate science in the first half of the 20th century. Logical positivists were strongly inductive, requiring a direct connection between theory and sensory evidence, and distinguishing between science and anything that could be deemed metaphysical or value-laden (p.69). They placed a strong emphasis on logic and semantics. After

thus 'positive' knowledge of the world, derived by observation and experimentation, and then interpreted using the rules of mathematical language and logic.[6] Science is thus promoted as the truth by its proponents, such as Gio Batta Gori, who see it as "the warrantor of factual verification in the real world" (Gori 1996, p.S4), as was briefly described in Chapter 5. Science achieves this special status "because of its objective ability to verify cause/outcome relationships" (1996, p.S4). Even though Gori acknowledged that there are no absolutes in nature, he regarded this as an "insignificant problem", for scientists can achieve "virtual verification . . . attained on the basis of sufficient criteria of probability" (1996, p.S4)—in other words mathematical logic. No other way of verifying knowledge about nature is recognised by positivism: if it cannot be factually verified, or virtually verified mathematically, then it cannot be said to exist or occur.[7] However, according to the analysis of Oreskes, Shrader-Frechette and Belitz (1994), virtual verification is an oxymoron: probability criteria cannot be used to verify knowledge about nature. According to the authors, verification cannot be achieved for mathematical models of natural systems because such systems are open. They are open in the sense that they require input data that is always incompletely known, and that observation and measurement of both independent and dependent variables are laden with inferences and assumptions. Chapters 3 and 4 have established that such problems occur in data input for pesticide risk assessment models. Oreskes *et al.* (1994) argued that, where verification means to establish the truth, and models of natural systems are inherently incapable of this, validation carries the lesser test of internal consistency and lack of detectable flaws. Validation establishes the legitimacy of a model but does not establish that the model will provide the truth.

World War II this movement gave way to Logical Empiricism, or Postlogical Positivism, the standard view of contemporary science, according to Moore (1999, p.70). The hall mark of this view is an abandonment of induction in favour of hypothetico-deductivism, in which "the truth of a theory could be ascertained by confirming hypotheses through objective observations" (Moore 1999, p.71). Karl Popper challenged this view by asserting that scientists could never prove any theory correct but only prove untrue theories false (Moore 1999, p.72). Thomas Kuhn further challenged the model when he asserted that the hypotheses scientist chose to 'prove' were only those that fitted within the prevailing paradigm, noting that choice was influenced by non-scientific factors such as professional advancement, personal preference, values, greed, etc. (Moore 1999, p.73).

[6] Critical theorists Max Horkheimer and Theodor Adorno (1944) commented that that which does not reduce to numbers is written off by modern positivism as "literature" (p.44).

[7] Fritjof Capra (1988b) reported, from a personal conversation with him, that RD Laing traced this belief back to a statement by Galileo, that "'Whatever cannot be measured and quantified is not scientific'" (p.133). This was later translated in post-Galilean science to mean "'What cannot be quantified is not real'" (p.133). The views of Descartes and the other mechanists appear to stem from Galileo. Laing regarded Galileo's view as a "'profound corruption from the Greek view of nature as *physis*, which is alive, always in transformation, and not divorced from us. Galileo's program offers us a dead world. . . . We had to destroy the world in theory before we could destroy it in practice'" (Capra 1988b, p.133).

The point is an important one, for public policy involving risk assessment is increasingly turning to mathematical models of verification and validation and, according to Oreskes *et al.* (1994), "claims" about verification and validation of model results are now "routinely found in published literature" (p.641), especially where there is an obvious public policy interest at stake. Such an exaggerated approach to describing the results of modelling helps to uphold the particular worldview that mathematics, and science in general, are the "supreme sources of truth" (Horgan 1996, p.33), a view that is countered by philosopher Nancy Cartwright who provocatively proposed that models are rather "a work of fiction" (Cartwright 1983, p.153, cited in Oreskes *et al.* 1994, p.644).

In exploring the concept of a new science, Merchant (1996) referred to the recent developments of chaos theory concerning the disorderliness and hence unpredictability of nature, in contrast to the mechanistic view of nature's orderliness, predictability and hence controllability. Newtonian closed systems and determinism are replaced by the postclassical physics of open systems and complex interactions. However, the analysis described above applies also to these relatively new scientific approaches of chaos and complexity, which pose challenges to the linear mathematical rationality of traditional risk assessment, and thus suggest a new approach. Where linear mathematics is reductionist in essence, complexity theory strives to encompass the whole through computer simulations based on chaotic mathematics, which is in turn based on the premise of predictable unpredictability. Complexity theory proposes that the natural world is ruled by extremely complicated patterns that never quite repeat themselves but which can be understood with the aid of powerful computers based on simple sets of non-linear mathematical rules (Horgan 1996, p.194). But whether a computer simulation based on chaotic mathematics would be able to provide a true picture of what happens when pesticides are sprayed in an agricultural system is open to doubt. When the topographical, microclimatic, and human behavioural variations that affect the outcome of a spray event are added to the various stressors that may be affecting not only the individual human but also beneficial insects, micro-organisms and native and introduced flora, then it begins to appear that the application of complexity simulation models to pesticide risk assessment may prove impractical. Additionally, according to Horgan (1996, p.206), Per Bak acknowledged that the concept cannot generate specific predictions, which is in fact what risk assessments are. It may, however, be useful to demonstrate the impossibility of standard risk assessment providing anything near the true picture of ecological risk from multiple and ongoing pesticide use. There is no reason why the comments, by Oreskes *et al.* (1994), on validation and verification of

presumably linear numerical models should not equally apply to models based on chaotic mathematics: that numerical models of natural systems cannot be verified, and therefore cannot be said to establish the truth.

Thus, a change in the mathematical approach to the assessment of pesticides does not solve the problem. Whichever way it turns, positivist science cannot provide the answers needed for ethical pesticide policy. Perhaps, then, policy must look in a different direction altogether to solve its problems, at different systems of knowledge.

Finally, before leaving the subject of positivism, it needs to be pointed out that the decision to adopt a positivist approach to knowledge is in itself a value judgement, one which firmly lays the burden of proof on the community to the benefit of the corporate owners of the technology, or the agency responsible for a problem. Consider that epidemiologists prefer to claim false negatives rather than false positives in determining causal links (Brown 1992, p.274). This means that they would rather claim that an association does not exist between a pesticide and a health effect when in fact it does exist, than to claim it does exist when it does not. The effect of this approach is well described by Beverly Paigen, a public health official involved in the Love Canal dioxin incident in the USA:

> Before Love Canal, I also needed a 95 percent certainty before I was convinced of a result. But seeing this rigorously applied in a situation where the consequences of an error meant that pregnancies were resulting in miscarriages, stillbirths, and children with medical problems, I realized I was making a value judgement . . . whether to make errors on the side of protecting human health or on the side of conserving state resources.
>
> Paigen 1982, cited in Brown 1992, p.274.

6.1.3 What happens when policy is based on positivist science

As already discussed in the previous chapter, it is the risk assessment process, rather than toxicology (including here ecotoxicology), that is deemed to be inappropriate as a basis for pesticide policy, although it was also posited that ecotoxicology is at odds with ecological rationality. Despite the problems with toxicology as detailed in the preceding three chapters, and the rejection of the flawed rationality of mechanism as a determinant of human or environmental safety, this form of science still has an important role to play in provision of information within pesticide policy. Just as physics has not thrown out the narrowly mechanistic Newtonian model with the advent of quantum physics, neither does the narrowly mechanistic model of toxicology have to be thrown out.

Newtonian mechanism has retained a useful role for a limited range of phenomena within the larger framework of quantum-relativistic physics (Capra 1988b, p.171). So, too, would toxicology retain a limited role within a broader framework for pesticide policy. The important point is to recognize the limited nature of the information that can be derived from toxicology. It can play an important role in comparing the hazard of one pesticide with another, within the confinement of the limited range of hazards that are recognized. Recall from Chapters 3 and 4 that not all hazards are included in hazard assessment. Endocrine disruption, synergistic or additive effects of mixtures, and influence on multiple chemical sensitivity are commonly missing. Toxicology can play a role in determining that a pesticide is too hazardous for any use. Toxicology cannot determine that a pesticide is safe to either humans or the environment, and herein lies its limitation, a limitation to which too little heed is paid in current pesticide policy.[8]

Graham *et al.* (1988, p.179-219) concluded, after their in-depth analysis of cancer risk assessment of formaldehyde and benzene, that the limitations of both epidemiology and laboratory animal assays mean that technical risk assessment will never be able to supply policy makers with the answers to the question 'how safe are these chemicals?'. They recognized that science has only a limited role in resolving the conflicts regarding chemicals, which properly are issues of democratic decisions. The authors acknowledged the range of scientifically plausible judgements that underlie differing technical assessments of risk and advocated full disclosure of these in the policy process, rather than the narrow uniform guideline approach which restricts expression of uncertainty and which has been increasingly adopted since their book was published. Yet they stopped short of admitting any other system of knowledge than that derived by scientific principles, even though they noted that:

[8] It should be recalled that toxicological risk assessment requires information about both hazard and exposure. There is the oft-repeated truism that 'there is no risk without exposure'. In other words no matter how great the hazard, if there is no possibility of exposure there is no risk. This is a general truism, but not particularly applicable to pesticides. By dint of the nature of their purpose, i.e. to kill pests, weeds and diseases in the environment, and the method by which they are usually applied, i.e. sprayed, there will always be exposure. They are deliberately applied to the environment, therefore there is exposure. That exposure may be minimal if the pesticide is injected in liquid form into the trunk of a tree. Nevertheless, human and environmental exposure still potentially occurs during manufacture, mixing, transport accidents, storage accidents such as fire, and disposal. Thus, it is contended that the main role of toxicology, post risk assessment, is actually in identifying hazard and environmental movement, and it is suggested that relatively greater effort should be expended in these areas rather than in trying to determine whether or not the hazard constitutes a risk that is acceptable, since this cannot be determined with any degree of certainty.

> . . . our case studies suggest, somewhat surprisingly, that at least so far scientific research has exacerbated policy disagreements as often as it has resolved them.
>
> Graham *et al.* 1988, p.179.

The problem of endocrine disruption

The issue of endocrine disrupting pesticides will be briefly reviewed to illustrate the dilemma facing pesticide policy makers who adhere to risk assessment and decision-making on the basis of mechanistic data and positivist science. Paralysis can be the result, as will be shown. Much of the following material is drawn from the very thorough and balanced review of the still unfolding 'environmental hormone' saga provided by Sheldon Krimsky (2000). That pesticides can cause endocrine disruption was first recognized as long ago as 1950, when Howard Burlington and Verlus Frank Lindeman noted that male chicks treated with DDT had smaller testes and arrested development of secondary sex characteristics (Krimsky 2000, p.6). The scientists actually identified an endocrine disrupting effect:

> The effects noted here are such that they might easily be duplicated by an administration of an estrogen. It seems, therefore, that the possibility of an estrogenic action of DDT is at least noteworthy of consideration. In speculating along these lines, it is interesting to note the degree of similarity between the molecular configuration of DDT and certain synthetic estrogens, especially diethylstilbestrol.
>
> Burlington & Lindeman 1950, p.51, cited in Krimsky 2000, p.6.

Yet, despite this discovery, despite concerns expressed by Rachel Carson about a possible role of sex hormone disturbance in the genesis of cancer (Carson 1965, p.207), and subsequent work by John McLachlan in the 1970s and 1980s on DDT and diethylstilbestrol, it was not until the 1990s that an 'hypothesis' began to emerge.[9] The hypothesis linked exposure to environmental chemicals to disease genesis through disruption of the endocrine system. It quickly gained widespread public, political and scientific attention. According to Krimsky, the hypothesis:

> . . . has the potential to change radically the way we think about the contribution of environmental factors to disease by shifting the focus from cancer and acute toxicity to the reproductive, neurophysiological, and developmental effects of chemicals.

[9] In 1971 John McLachlan began investigating the estrogenic effects of DDT at the USA's National Institute of Health in the USA. In 1979 he organised the first symposium on oestrogens and the environment, and a second one in 1985 (Krimsky 2000, p.11-4).

Krimsky 2000, p.3.

When Theo Colborn, a biological scientist and wildlife enthusiast working for environmental NGOs, began drawing together the disparate bits of evidence emerging from wildlife research and synthesizing these into a new theory of environmental disease, serious attention was finally turned to the global ramifications of endocrine disrupting chemicals.[10] Colborn worked assiduously to collect research material from the fields of biology, biochemistry, toxicology and zoology and to link these with human health effects. She worked to develop a broad consensus between a number of scientists, resulting in the First Wingspread Statement of Consensus, which was signed by twenty-one scientists in 1991. This statement drew attention to the potential public health implications of Colborn's findings, as well as those of other scientists, such as McLachlan.

Two other major areas of investigation, besides the wildlife studies, have contributed to the endocrine disruption hypothesis—that of male infertility and testicular cancer, and that of breast cancer.[11] Controversy surrounds the issue of declining sperm counts, with some researchers linking a decline to environmental factors,[12] and others believing that the decline did not actually exist but was merely a feature of geographical variation[13] (Krimsky 2000, p.29-36). Krimsky noted, however, that the "supporters of the sperm decline theory found strength in numbers", with nineteen scientists co-authoring a long scientific review that confirmed a "striking decline in sperm counts" (p.36).[14] Similarly, controversy surrounds the linking of the rise in breast cancer rates, from one in twenty women in the 1940s to one in eight women in the 1990s, at least in part to environmental oestrogens (Krimsky 2000, p.38). Krimsky (2000, p.40) noted that whereas some scientists posit a connection between xenoestrogens and breast cancer,[15] there is "strong

[10] The evidence related primarily to biomagnification of chemical pollutants in the food chain, and to eggshell thinning, population decline, reproductive effects, wasting, gross defects, metabolic and thyroid function abnormalities, and behavioural changes in fish and fish-eating birds and mammals. Colborn noted that the effects were experienced primarily by the offspring of adults eating chemical-contaminated food, rather than by the adults themselves (Krimsky 2000, p.16-9).

[11] The recognition of the effects of the synthetic oestrogen diethylstilbesterol (DES), on the offspring of pregnant women and animals who had taken it, also contributed to the endocrine disruption hypothesis. DES had been shown to cause cancer, cryptorchidism, epididymal cysts, hypoplastic testes, sperm abnormalities, prostatic inflammation, reduced sperm count, and lower quality sperm (Krimsky 2000, p.10).

[12] For example Sharpe & Skakkebaek 1993.

[13] For example Fisch & Goluboff 1996; Paulsen, Berman & Wang 1996.

[14] Toppari, Larsen, Christiansen *et al.* 1996.

[15] For example Davis, Bradlow, Wolff *et al.* 1993.

receptivity within the industrial sector to any evidence refuting this thesis" (p.42).[16] Later, neurophysiological effects became included in the hypothesis when it was recognized that early foetal exposure to environmental chemicals could interfere with the hormone thyroxin and thus with normal brain development (Krimsky 2000, p.46).

McLachlin noted one of the most crucial aspects of Colborn's work:

> Theo pulled us together. . . . We hadn't read each other's literature.
>
> McLachlin, cited in Krimsky 2000, p.26.[17]

This statement is of quite profound importance, for it illustrates how the reductionist approach of science had allowed the implications of endocrine disrupting chemicals to go so long unrecognised from the time they were first observed in 1950. Krimsky (2000, p.52) reported that, between 1970 and 1995, at least seventy studies were published showing evidence of endocrine effects of specific industrial chemicals, pesticides, and sewerage discharges on fish, mammals, birds, reptiles, echinoderms, worms, molluscs and zooplankton. A number of studies from 1969 to 1995 also found associations between human health effects and endocrine disruption. But no one was thinking holistically until Colborn took up the issue. Krimsky said that Colborn's "creative contribution was the discovery of patterns" (p.54):

> She kept seeking the forest whilst everyone else was still looking at the trees.
>
> Krimsky 2000, p.54.

Krimsky commented that, for example, biomedical scientists rarely consult more than half a dozen journals on an ongoing basis (2000, p.88).

The colliding of these different areas of research, and the work of Theo Colborn in publicizing her concerns, led to the emergence of the endocrine disrupting hypothesis as a major public issue in the United States. In other countries it has emerged to a greater or lesser extent on the tail of Colborn's work and the US public policy response. Congressional hearings in 1991 and 1993 set the political scene in the USA, with eight bills addressing the issue introduced into the House in 1993 and 1994. Finally, in 1996, the Food Quality Protection Act was signed into law, forcing the EPA to "require data or information pertaining to whether the pesticide chemical may have an effect in humans that is similar to an effect produced by naturally occurring oestrogen or other endocrine effects" (Food Quality Protection Act 1996, cited in Krimsky 2000, p.68-9).

[16] Krimsky cited as evidence Safe & McDougal 1997.
[17] Krimsky sourced this statement by McLachlin from Wapner 1995.

Since that time, an examination by the EPA of nearly 300 peer-reviewed studies concluded that, with very few exceptions, they could not draw a cause and effect relationship between endocrine disruptors and human disease or abnormality (Krimsky 2000, p.86). Similarly, a National Academy of Science report appeared to conclude that they "could not say with confidence whether endocrine disruptors in the environment posed a major threat to the general population that required an immediate response" (Krimsky 2000, p.86).

Despite spending large amounts of money on the problem, for example US $30-50 million in 1997 (Krimsky 2000, p.81), there is still no agreed battery of tests to define what is and isn't an endocrine disrupting chemical—fifty years after the first identification of the potential problem.

Thus, the policy problem is revealed. Science favours mechanistic explanations for things and indeed positivist science will not accept that a cause and effect relationship exists until the mechanism by which such an effect occurs is fully understood. Hence the difficulty in accepting multiple chemical sensitivity as described in Chapter 4. Hence, also, the difficulty in accepting the endocrine disruptor hypothesis—for the mechanisms underlying many of the effects are still not clearly understood. Studies that demonstrate an association between endocrine disrupting chemicals and, for example, breast cancer are discredited by a single negative finding and the lack of a testable biochemical pathway of action (Krimsky 2000, p.128). This problem, together with the difficulties presented by cumulative effects, delayed effects and possible synergism of many chemicals, makes the verification of links between chemicals and health outcomes very difficult:

> Even if damage is apparent and documented, however, it will never be possible to establish a definitive cause-and-effect connection with contaminants in the environment. Although we know that every mother in the past half century has carried a load of synthetic chemicals and exposed her children in the womb, we do not know what combination of chemicals any individual child was exposed to. Or at what levels, or whether he or she was hit during critical periods in their development when relatively low levels might have significant lifelong effects. This is a common and inescapable dilemma in trying to assess the delayed effects of environmental contamination. We also face the problem of having no genuine control group of unexposed individuals for comparative scientific studies. The contamination is ubiquitous. Everyone is exposed to some degree. For these reasons, those who demand such "definitive" proof" before reaching a judgement are certain to be waiting an eternity.

Colborn *et al.* 1996, p.196.

Obviously the policy sector cannot wait for eternity to arrive to make decisions about the problem of endocrine disruptors. The view among conservative law makers and regulators is that they should not take action until there is sufficient evidence of risk, with the threshold for regulation being the threshold for scientific publication of a cause-effect relationship (Krimsky 2000, p.150). The positivist science approach is that of basing policy on sound science, rejecting any policy action being taken on a precautionary basis. Thus, in the absence of an understanding of the mechanisms involved and of established proof, no action should be taken against endocrine disruptors. Such an approach is, of course, well supported by the chemical industry. Given the wealth of literature signifying an associative, suspected or correlative linkage (which demand lesser levels of proof than causal relationships) between endocrine disruptors and adverse effects on wildlife and humans, it seems hardly rational, or logical, or wise, to wait for eternity before taking policy action on a group of chemicals that may be exerting a profoundly negative effect on humanity and the ecosystem. Currently, more than seventy chemicals, of which about fifty are pesticides or their breakdown products, have been implicated in endocrine disruption (Krimsky 2000, p.121,203-4).

This lengthy discussion of the endocrine disruptor hypothesis, whilst seemingly diversionary, has in fact served to illustrate the effect of the use of scientific knowledge as the predominant arbiter in the policy process: endocrine disrupting effects remain largely unregulated fifty years after they were first acknowledged. Pesticide users continue to harm the environment, and will continue to as long as policy makers are burdened with the positivist approach. It is worth recalling from the discussion on toxicology in Chapters 3 and 4, that not all possible hazards that pesticides can cause are addressed by the toxicological risk assessment process. Only some hazards are acknowledged, and from the above analysis it is evident that endocrine disruption has not been one of them. David Henderson made the following comments on this subject:

> Ultimately, we are limited by our imaginations as to possible hazard. Only recognised hazards can be tested. . . . Many practices that now produce outraged calls for regulations were begun because people could not imagine the types of hazards involved. Because they couldn't imagine the hazards, there was no reason to test for them.
>
> Henderson 1993, p.105.[18]

[18] David Henderson, Professor of Chemistry, Trinity College, Hartford College, Connecticut.

Ultimately, then, positivist science appears to rest on a foundation of imagination.

6.2 The admission of wisdom into pesticide policy

> As *Homo scientificus* we reduce our cognitive apparatus to our dead artificial world, instead of using and qualifying our entire organ of cognition, which in reality is equipped to know everything, as illuminati have always taught.
>
> Bahro 1994, p.144.

Many critics of modern science, and the uses to which it is put, argue for an end to the Cartesian dualism of mechanism that segregates one form of thinking from all others. Bosselmann (1995, p.102) argued that an ecocentric ethic gives rise to an epistemological framework in which the dualism of scientific rationality gives way to a holism that connects the two opposites into one. Perception and observation are seen as mutually dependent. Intuitive aspects of understanding have equal rights to those of analytical understanding. He concluded:

> We cannot afford to wait any longer for natural scientists to confirm, at some unknown date in the future, what we have known intuitively for a long time: namely, the fact that Earth has to be understood as a living organism. Nor can we wait until all scientific and ethical doubts have been dispelled about the fact that we have to change our basic attitude towards nature: this, we have also 'known' for a long time.
>
> Bosselmann 1995, p.314-5.

Bosselmann's argument in favour of reuniting the intuitive and the thinking knowledge systems is echoed by many others, such as Fritjof Capra in *the Tao of Physics*. It is the thesis, too, of feminist writers such as Adrienne Rich (1976). Merchant (1996) made mention of an approach to science that differs from that of the positivist—a "feminist science" that "unites hand, brain and heart" (p.206), which views nature as a self-generating, complex and resourceful process rather than the passive, simple, useful resource which positivist science regards it to be. Consciousness, Merchant (1996, p.xix) asserted, is a much broader way of knowing nature. By consciousness she meant all the senses working together—feelings, volitions, thoughts.

Many of these comments resonate with those of Deborah Moore (1999) who, in her PhD dissertation on the admission of anecdotal evidence to western medicine, argued persuasively for the re-emergence of wisdom as a basis for decision-making. Noting that science has come to command the highest degree of cognitive authority, and thus

has earned the greatest degree of respect and influence in the wider society, Moore (1999, p.3) drew attention to the greatest loss in this process—that of human wisdom. Human wisdom she described as a complex human quality, that generally refers to "the highest order of moral and epistemological achievement" (p.2). Noting, also, a "critical dearth" of wisdom in science (p.4), Moore traced the historical processes by which wisdom was forsaken. Not surprisingly, this mirrors closely the development of mechanism in science and the concomitant technological materialism that was detailed in Chapter 5. Wisdom, revered throughout human history, fell foul of mechanism. As mechanism arose, so wisdom subsided. 'Knowledge-as-information' took the place of 'knowledge-as-wisdom'. In the process, science discarded the systematic use of anecdotes or stories as sources of information, tossing out with this traditional approach to knowledge much of the contextual holistic richness that had yielded accumulated wisdom (Moore 1999, p.5).

Moore then argued that wisdom can find its place in the 'Western scientific enterprise', within an expanded holistic outlook that can be aided by the critical use of anecdotal evidence, backing her philosophical arguments in part with medical case studies. It is not the intention here to argue for or against the inclusion of wisdom or anecdotal evidence in medical science, or for any other form of science. The emphasis in this thesis is on pesticide policy rather than on science, hence the task at hand is to decide what type of knowledge should be admitted to the policy process. Thus, the intention here is to demonstrate the wisdom of incorporating wisdom into pesticide policy, including, but not limited to, the application of anecdotal evidence. Such an argument is easier to sustain than that of the inclusion of anecdotal evidence in science. As Moore has already successfully argued the latter, the former becomes much easier. It is therefore worth visiting some of her arguments, and the sources she drew on, and applying them to pesticide policy, before moving on to examine the potential role of anecdotal evidence and other aspects of wisdom in that policy.

6.2.1 Wisdom defined

Wisdom, according to the Oxford Dictionary, is:

> . . . the quality of being wise, esp. in relation to conduct and the choice of means and ends; the combination of experience and knowledge with the ability to apply them judiciously; sound judgement, prudence, practical sense.
>
> Brown 1993, p.3700.

Contemporary psychologists have begun to take an interest in wisdom and in determining its nature, so a brief review of some of their studies might help elucidate what kinds of information may assist in pesticide policy. Gisela Labouvie-Vief saw wisdom in the modern context as a re-uniting of the two elements of thought suggested by the ancient Greeks: *mythos* and *logos*. *Mythos* means 'speech', 'narrative', 'dialogue', and in the context of wisdom refers to the holistic experience derived from a close identification between the self and the object (Labouvie-Vief 1990, p.55-6).[19] *Logos* derives from 'gather', 'read' and has come to signify 'counting', 'reckoning', 'explanation', 'rule', 'principle', and 'reason'. It refers to the disembodiment of meaning from experience, rendering it the subject of definition, precision, and mechanical, computable, and deductive certainty (Labouvie-Vief 1990, p.55-6). Thus, *logos* represents the rationalist, scientific positivist mode of thinking that has come to dominate society's handling of knowledge and therefore the admission of knowledge to the policy process. This has caused the *logos* mode of thought to be determined as the only rational mode, and that of *mythos* to be deemed irrational. But Labouvie-Vief asserted that wisdom is, in fact, "the grounding of intellectual operations—those usually associated with *logos*—in *mythos*" (p.76). She noted a general movement towards this reintegration, bringing with it a "broadened definition of intellectual processes as including emotional, ethical, expressive, and mythic ones" (p.76). Wisdom, she asserted, "cannot be reduced to a cognitive theory of expertise" (p.77). The concept of wisdom is directed away from expertise and towards a more "integrative, organismic knowledge" (Labouvie-Vief 1990, p.77).

James Birren and Laurel Fisher (1990) expanded on this concept slightly with a view that wisdom can be considered "a blending of cognitive (thinking), affective (feeling) and conative (acting, experiential) elements" (p.321). Drawing on these, and many other authors, Moore depicted wisdom as having two facets, as being:

> . . . **a way of knowing** that informs one's conduct and relations with the world; *as well as* **a species of accumulated knowledge** that is broadly holistic in its content and completely internalized, enabling profound insight and broad foresight [emphasis original].
>
> Moore 1999, p.21.

Wisdom, then, draws on:

> . . . knowledge that is broad and deep, including intuited knowledge, and is informed by emotion. As a species of accumulated knowledge, it

[19] Gisela Labouvie-Vief, Department of Psychology, Wayne State University, Detroit.

> seeks to continually widen and deepen what is known, building on interconnections between all things, and based largely on personal experience.
>
> Moore 1999, p.22.

Thus, Moore's analysis reflects those comments by Bosselmann and Merchant reported previously in this chapter. Not surprisingly, the elements of wisdom that Moore emphasized were common sense, intuition, experience, and holism, the elements long denied by *logos*. Those who seek wisdom are open to learning from novel experiences and to using all kinds of information, including that which provides context and heuristic content (Moore 1999, p.26). She also emphasized the ability of wisdom to provide foresight and "broad, sometimes cautionary information", an element that is crucial to pesticide policy, but lacking in that policy which is based on probabilistic risk assessment. Moore drew particular attention to the holistic aspect of wisdom and its appreciation of the interconnectedness of the universe, a key element in rejecting mechanistic rationality in favour of ecological rationality in Chapter 5:

> Knowledge-as-wisdom strives to see the interconnections, the whole picture, and allows for the mutual support among all parts of the whole, aiding in the coherence and longevity of all pieces of society.
>
> Moore 1999, p.35.

There can be little question, then, that wisdom must become an integral part of pesticide policy, for the coherence of society should be a thread running through all public policy and, as will be shown in the following illustration, pesticides profoundly effect the coherence of society.

A recent study of the effects of pesticides on women in Bangladesh revealed that many farmers had come to recognize the social devastation wrought by the so-called 'green revolution' package of high-yielding rice varieties, chemical pesticides and fertilizers, and irrigation, a devastation that Farida Akhter (1999) referred to as "a disaster Bangladesh can hardly survive" (p.27):

> Women are angry. They say so called modern agriculture has destroyed our lives, our society, our culture, our land, our soil, and the life forms around us which sustain us. The male farmers who became greedy for two generations, are ashamed of their foolishness. They miscalculated the benefit—misunderstood the message. The loss of a huge variety of paddy crops, fish, vegetables and fruits is now a tragedy for the country.

Akhter 1999, p.27.[20]

Also included among the side-effects of this technological package, are critically high levels of arsenic in drinking water as a result of the serious depletion of groundwater to satisfy irrigation demands, and violence against women as a result of the increasing poverty, disease and loss of respect for women's traditional role in agriculture (Akhter 1999, p.27-8). Arsenic levels in drinking water are not normally considered in pesticide policy, nor is family violence, yet they are effects of that policy in Bangladesh, according to Akhter. Pesticide policy cannot be separated from the wider agricultural paradigm that demands chemical support, nor from the social paradigm that allows even encourages it.

Through the wisdom of the women farmers working within the *Nayakrishi Andolon*, the new agricultural movement, agricultural production is again being recognised as an act of *Ananda*, "the materially and culturally rich joyful relation of human existence" (Akhter 1999, p.27), a celebration of life that "constructs familial and community relations" (p.29). By mid 1999, more than 50,000 farming households in Bangladesh were practising *Nayakrishi* (Akhter 1999, p.29). Akhter referred to the use of the term *beesh* to describe pesticides, as "genuine wisdom" (p.26): *beesh* literally translated means poison.

Intuition

If intuition is to be countenanced in pesticide policy, it is worth looking more closely at what it means. Philosopher Mary Midgley (1989) referred to intuition as "any view of one's study which is held by people without one's own training, is expressed in everyday language, and does not require special methods to establish it" (p.55). This meaning, she noted, is one that has arisen amongst physical scientists, and has from there invaded other kinds of thinking. Although it portrays the dismissive attitude of the sciences towards knowledge possessed by those outside their discipline, as being *not science*, it differs from the traditional meaning of the term. Midgley (1989) claimed that the term meant "a direct perception" (p.55). The Oxford Dictionary defines intuition as:

> Spiritual insight or perception; . . . immediate apprehension by the mind without intervention of reasoning, direct or immediate insight; . . . immediate apprehension by the intellect alone; . . . immediate apprehension by a sense or senses; . . . the action of mental examining; contemplation; consideration; perception, recognition.

Brown 1993, p.1407.

[20] Farida Akhter, UBINIG (Policy Research for Development Alternatives), Dhaka, Bangladesh.

The Oxford Dictionary also provides an explanatory quote from John Stuart Mill:

> The truths known by intuition are the original premises from which all others are inferred.
>
> Brown 1993, p.1407.

Thus, it seems types of knowledge that are accepted in philosophy are dismissed by science, which has systematically secluded itself from all types of knowledge that do not follow the rules it has imposed on all. This "ideological imperialism" (Midgley 1989, p.84) has successfully undermined all other knowledge systems to the extent that intuitive or common sense recognition by lay people of the dangerous aspects of pesticide technology, are met by a self-righteous chorus of 'prove it' according to science's rules. Science, noted Midgley (1989), is actually only a "small and recent branch on the tree of human knowledge" (p.112), and itself was dependent for its genesis on pre-existing knowledge. Without this already existing enormous body of knowledge science could not have got started. If this knowledge is not knowledge because it isn't science, then how can the science that rests on it be knowledge either?

Truth and objectivity revisited

To those who hold science as sacrosanct and the supreme generator of knowledge, the only truth, the concept of admitting intuition, emotion, and personal experience and observation, i.e. wisdom, into the policy process must seem like a nightmare. Science, after all, "is counter-intuitive and opposed to common-sense", according to Jennie Popay and Gareth Williams (1996, p.764).[21] And there can be no question that pesticide science is NOT a pursuit of pure truth. As Moore (1999, p.40) put it, science has become entangled with corporate technology, politics and social values. Krimsky (2000, p.187) reported that, in 1988, at least 39 percent of the biological scientists that were members of the USA's prestigious National Academy of Science (NAS) had undisclosed ties to companies. The NAS conducts many studies for government agencies by convening expert panels. The NAS itself acknowledged that "evidence that science has been censored or distorted to favour particular interested parties has long been a source of conflict over risk characterizations" (NAS 1996, cited in Charnley 2000, p.10). Additionally, a 1996 study of fourteen biomedical journals revealed that 34 percent of the articles published in 1992, by Massachusetts based contributors, had at least one lead author with an "undisclosed financial interest in the research being reported" (Krimsky

[21] Jennie Popay, Gareth Williams, Public Health Research, and Resource Centre and Institute for Social Research, University of Salford, England.

2000, p.187).[22] When science becomes "morphed" into the business world of profit, status and career advancements, it becomes vulnerable to the production of fraudulent data (Moore 1999, p.200). Nowhere is this truer than in toxicological risk assessment, designed to facilitate the marketing of chemical technology and in which it is the chemical corporates that provide the data on which the assessments are made and policy decisions taken. Not surprisingly, there are a number of reported cases of fraudulent data from, and discarding of valid adverse scientific information by, pesticide companies and associated laboratories.[23] Yet still the policy process is married to the pesticide proprietors through the latter's provision of the data. Ethically, the data should be derived by bodies that are not susceptible to pressure by the companies but at their expense. It is difficult to know what bodies these may be. Certainly, so-called independent agencies, or even government employees, can not be guaranteed immunity to coercion.

If it can be recognized that toxicological risk assessment is not a purely scientific pursuit, and indeed is a pursuit that is vulnerable to corporate deceit, then it becomes easier to admit wisdom to the policy process.

Moore also tackled the issue of objectivity, the perceived role of it in science and lack of it in all that is not science. The lack of it in science has been well covered already in this thesis. Of more interest here, then, is Moore's (1999) holistic perspective of objectivity, in which she saw true objectivity, not as detachment, but rather as "a better view of the whole" (p.117). Moore (1999) contended that the objectivity that potentially can be

[22] Krimsky cited Krimsky, Rothenburg, Stott & Kyle 1996; also Krimsky, Ennis & Weissman 1991.

[23] 1. Eleven animal tests carried out on chlordane and heptachlor between 1959 and 1972 were withheld from the US EPA until a court ruled that the studies be released. The studies were purported to conclude that the pesticides posed no significant threat to the unborn but, when the raw data were re-analyzed, the opposite was found to be true, according to Dr Kate Short (1994, p.172). A later review found "a high incidence of unequivocal liver cancer, which in most cases were statistically significant" (Epstein 1990, p.448, cited in Short 1994, p.185).
2. Industrial Bio-Test, the USA's largest independent testing laboratory, was found to have routinely falsified data on 140 different pesticides. The EPA reviewed 801 of its studies on the pesticides and found 74 percent to be invalid. In 1981 four employees were indicted and charged with falsification of data (Short 1994, p.182).
3. In 1991 the US EPA placed Craven Laboratories in Texas under investigation for falsifying residue data for at least seventeen pesticides. They were convicted in 1992 (Short 1994, p.186-7).
4. In 1995 the federal judge in Columbus, Georgia, fined pesticide manufacturer DuPont US $101 million for withholding research data and misrepresenting results during a trial over the fungicide Benlate. Judge Elliot said that "put in layman's terms, DuPont cheated. And it cheated consciously, deliberately and with purpose" (quoted in Bane 1995; Bane cited Mio 1995). Doyle (1992) reported other incidents in which DuPont had fallen foul of the law, requiring then to pay out nearly a million US dollars per month, between May 1989 and July 1991, in "environmental and public safety fines, penalties and lawsuit settlements" (p.86).

gained from stepping back and looking at a situation, is not due to "separating oneself from the object", the claim of science, but rather it derives "from putting oneself in the vantage point of better perspective: stepping back, one can see more of the whole picture" (p.117).

Gender

The problem of gender becomes inescapable when discussing the issues surrounding wisdom and science, and especially where these impinge on pesticides. It has already been said that wisdom involves intuition, emotion and common sense, exactly those qualities that are generally attributed to women and their epistemic processes, and generally in a disparaging or patronizing manner. It is these subjective attributes of women's "ways of knowing" (Belenky, Clinchy, Goldberger & Tarule 1986) that are frequently used to undermine the validity of their beliefs, just as it is these attributes that are frequently used to underline lay assessment.[24] Not surprisingly the two issues collide. It has already been pointed out in Chapter 2 that women, including women toxicologists, tend to regard pesticides as being of higher risk than do men, and that women predominate in the grass roots anti-toxics movements. It was women, too, who formed the backbone of the peasant farmers' challenge to the scientific agriculture paradigm in Bangladesh. The *Nyakrishi Andolon*, the New Agricultural Movement, which is reconstructing rural society in Bangladesh, started as a women's movement (Akhter 1999, p.27). According to Moore:

> . . . [women's] subjectivist epistemology endorses an empathic, holistic understanding, one that is grounded in concrete, personal concerns, engendering common sense decisions rather than the abstract, rational policy-making that is cultivated in a male-oriented and professional world.
>
> Moore 1999, p.164.

Phil Brown couched the same idea in the context of rationality, asserting that the gender differences in response to environmental pollution should be viewed as representative of differing cultural rationalities (1992, p.276).[25] Brown and Ferguson also referred to the fact that it is often women that are at the heart of the lay action on health issues, noting that:

[24] It is not being suggested here that only women can achieve wisdom, although Birren and Fisher did report that "historically, wisdom has been personified, almost always, as female in character" (1990, p.318). It is suggested that generally speaking, and acknowledging exceptions, men may need to re-learn what wisdom is, regain it and acknowledge its importance in decision-making processes.
[25] Phil Brown, professor of sociology, Brown University, USA.

> . . . women activists bring to their work the ability to transform everyday experiences, mostly typically their own and their neighbour's children's illness, into knowledge which they can use in the struggle against toxic waste, and to insist on its validity as knowledge.
>
> Brown & Ferguson 1992, p.5, cited in Popay & Williams 1996, p.760.

They then argued that the validity of this knowledge:

> . . . is contested by scientific experts and professionals, whose cultural beliefs about women and science lead them to refuse to accept the women activists' claims about the consequences of toxic waste.
>
> Brown & Ferguson 1992, p.5, cited in Popay & Williams 1996, p.765.

Toxic waste or pesticides: the situation is exactly the same. This attitude is as old as science itself and, as previously discussed in Chapter 5, comes bound up in a raft of other non-rational, subjective values:

> The principal feature which appears to me to characterize the Caucasian race, to raise it immeasurably above all other races, is the power that many of its male members have of advancing the horizons of science, of penetrating beyond the existing limits of knowledge—in a word, the power of scientific discovery. I am not aware that the female members or our race participate in this mental power, in this supreme development of the human mind.
>
> Bennet 1870, cited in Midgley 1992, p.68.[26]

Society today is less accepting of the medical gentleman's attitudes towards other races and the ability of the female to indulge in scientific thinking, but the belief in the supremacy of science still holds, *especially* in pesticide policy.

In summary then, there are two main grounds on which the admission of wisdom to pesticide policy is legitimated. The first of these is the debunking of the myth of science as having total claim to objectivity, logic and rationality. It has been adequately demonstrated throughout this thesis that toxicology, the science behind pesticides, is influenced by value systems and cannot be conceived of as objective. The rationality on which toxicology is based has been found to be flawed because it contradicts ecological rationality, thus there is no logical basis for assuming that the resultant risk assessments can determine the actual risk a pesticide poses. It becomes evident that pesticide science

[26] Midgley sourced the quote from Bennet in Easlea 1980.

is a culturally biased social endeavour, one that is riddled with uncertainty and propped up by the imperious dismissal of other knowledge. The second ground is the recognition of the positive contributions of wisdom in providing context and a wider view of the whole, which is the manner in which Moore re-defined objectivity.[27] One contribution that wisdom proffers is asking the question "what is it that matters?" (Moore 1999, p.146). The answer with respect to pesticide policy is, as was argued in Chapter 5, the management of pests, weeds and diseases in a manner that causes minimum damage to the environment, including humans, and enables sufficient production of food and fibre to meet human needs.

Admitting wisdom to pesticide policy, then, means admitting common sense, intuition and emotion, admitting a contextual and holistic view of the hazards and the benefits of pesticides within the broader ecocentric ethical basis. It should be recalled from Chapter 5 that two branches of physical science lent support to the notion that context is of the utmost importance in knowledge. Firstly, quantum physics emphasizes the importance of context in terms of the behaviour of matter and energy.[28] Secondly, and perhaps more pertinently, Landis (1998) drew attention to the importance of context in terms of the effects of 'environmental stressors' on the environment. Thus it seems logical that, in determining the effects of pesticides, information that provides a contextual background is a necessary addition to the reductionist data supplied by toxicology and wholly lacking in context. Context and 'exposure' as used in a risk assessment model are completely different concepts, the one being reality and the other being a mathematical estimation. In Chapter 3 it was suggested that risk is not only a question of the standard hazard and exposure factors but also has a third factor, referred to as the state of reality by Renn (1992, p.58) and as the interaction with the human being by Miller (1997). In this sense the actual experience of people, or the ecosystem, is the missing contextual element of toxicology.

Finally, it is worth noting John Meacham's argument that the essence of wisdom is to know that knowledge is fallible and to strive for a balance between knowing and doubting (1990, p.209).[29] This view also expresses an important relationship between wisdom and pesticide policy, for as has been made abundantly clear throughout this

[27] Toxicology, however, is not without context. As Michael M'Gonigle from the University of Victoria, British Columbia, pointed out "all knowledge is contextual", hence even toxicological knowledge is contextual in that it is "embedded within economic and political institutions that have their own imperatives and own dynamics" (1999, p.33). The context that can be supplied by wisdom, however, is that which cannot derive from toxicology, namely the experience of pesticides in real life situations.
[28] "The quality of the thing depends on its context" (Bohm 1998, p.347).
[29] John Meacham, Department of Psychology, State University of New York at Buffalo.

thesis, there is much that is not known about the effects of pesticides, yet the *logos* rationale prevents not only the expression of doubt within the policy, but also the adoption of improved methods of dealing with it:

> Knowledge is expressed in declarative certitudes, whereas wisdom must compare, raise questions, and suggest restraints. Hence wisdom rarely gets much respect and is seldom popular. Yet an evolutionary analysis suggests that unless we cultivate an interdisciplinary knowledge of our systemic needs, we shall not be able to understand what is happening, and we shall not be able to see what is good or bad for us in the long run.
>
> Csikszentmihalyi & Rathunde 1990, p.36.

6.2.2 Anecdotal evidence

There are a number of ways in which wisdom can be admitted to the pesticide policy process. One of these is the incorporation of anecdotal evidence. Moore (1999) noted that anecdote is associated with ordinary-language expression: "the inexact, emotion- and value-laden, generally 'sloppy' and unsystematic" (p.165), none of which, she added, precludes it from being truthful.[30] The bearer of anecdotes is neither more nor less capable of untruths than a scientist. Further, she argued that anecdotes have a better chance of being truthful because they promote a more holistic understanding through the richness of context that they carry with them. Anecdotes thus have an advantage over science in the way that they promote understanding, not simply knowledge. Understanding the way in which pesticides interact with people's every day lives can be conveyed by anecdotes, but it is beyond the scope of the scientific knowledge that is derived from laboratory studies on rats. It is not difficult to conclude that the former is of greater importance to society than the latter. Additionally, it can be argued that the former constitutes empirical evidence, whilst the latter is better characterised as academic guesswork (estimation) based on metaphysical models, a simulation of reality but not actual reality.

[30] Recall from Chapter 1 the discussion about the power of language and the way in which it can be used in policy to promote one set of values and create bias against another. This is one such example. Both anecdotes and ordinary common sense are "not accessible in the precision of scientific language and technical writing" (Moore 1999, p.173). Thus, the "overstated importance conferred on rigor, quantifiability, and objective detachment, none of which are characteristics of ordinary language", mitigates against anecdotal evidence (Moore 1999, p.173). Latour also claimed that the significant difference between a scientific account and an anecdotal one is that the former has undergone a rhetorical makeover, and the latter has not, according to Moore (1999, p.184, citing Latour 1987).

Moore (1999) argued that anecdotal evidence can be "a tool for a more holistic approach to practicing science", as it reflects "an acknowledgement of context and relation" (p.143), an acknowledgement that is missing from toxicology. She argued that it makes intuitive sense to use anecdotal evidence in scientific endeavours, so long as it is used "critically, that is self-consciously, conservatively and systematically" (p.143). Moore's criteria for the acceptability of anecdotal evidence will be provided later in this section.

Expanding this concept to pesticide policy, it is contended that the use of anecdotal evidence provides context and relation for that policy. Anecdotal evidence becomes vital in pesticide policy, when it is understood that it is actually the most practical method of obtaining the necessary information on which to base decisions about health effects of pesticides on humans. It is not generally possible to verify the toxicological risk hypothesis regarding the safety of a pesticide to humans, that verification being the preferred methodology of positivist science. For it is not considered ethically acceptable these days to deliberately expose, for example, small schoolchildren to the herbicide 2,4-D in order to determine what the effect might be.[31] It is possible to wait for results of epidemiological studies in which the adverse effects experienced in a statistically significant number of accidentally exposed school children are compared with those not exposed.[32] However, this may require a long wait, indeed even 'unto eternity', and it can be argued that this deliberate waiting for a statistically significant number of exposures to occur ethically amounts to the same thing as deliberate exposure. If, however, a teacher provides evidence of her experience of the effects children suffered when they were potentially exposed, should not, logically, the pesticide policy process take this anecdotal evidence into account? What follows is an account from a school teacher in Northland, New Zealand, a rural region in which there is a high rate of aerial spraying of 2,4-D each winter, with numerous ensuing reports of spray drift incidents and adverse health effects:[33]

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[31] According to Dr Steinberg of the Albert Einstein College of Medicine, "human exposure to pesticide testing and experimentation is not warranted without a stringent ethical review" (Steinberg 2000, p.A109). Yet Steinberg reported that a number of pesticide manufacturers are now using human subjects in their pesticide studies. Even teenagers have been used with parental approval. Steinberg also pointed out that much of the testing is likely to occur on people from lower socio-economic groups, and that "the concept of duress by economic incentive cannot be dismissed" (p.A108).

[32] There are already a number of epidemiological studies that link 2,4-D to reproductive problems, birth defects and non-Hodgkin's lymphoma in farmers, pesticide applicators and their children and chemical factory workers e.g. Hoar *et al.* 1986; Bond *et al*. 1988; Wigle *et al.* 1990; Zahm *et al*. 1990; Lerada & Rizzi 1991; Garry *et al*. 1996. There are also other epidemiological studies that have failed to find a relationship between 2,4-D and non-Hodgkin's lymphoma, according to Cox (US EPA 1997, cited in Cox 1999a, p.16).

[33] For example Jarman 1995; Sommerville 1996; Sinclair 1996; Dempsey 2000; Newman & Searle 2000; Scott 2000. In addition, the Northland Regional Council recorded 412 2,4-D related spray drift incidents between 1 October 1995 and 30 December 1999 (Boynton 2000).

> The children in my rural-area classroom suffer symptoms during the winter months (May-August) which doctors are very often unable to identify. They display such symptoms as compulsive licking around their mouths to cause large damaged areas, sores in the corners of lips, rashes over their faces, lowered immunity levels leading to severe colds and flus, spates of headaches that are continual and unresponsive to Panadol, depression, unexplained high temperatures, tearfulness, hearts that they say are racing "like I just got a big fright" and others. I also notice that the school sickbay register shows a large increase in headaches and flu-like symptoms during the 2,4-D spray season. I know of some children whose doctors diagnose their condition as 'walking pneumonia', or 'slapped cheek disease' or 'stress'. Children have sometimes appeared with high temperatures, eyes glazed, and an excruciating headache. On being questioned about what they had been doing, one said he had been out spraying thistles with his grandfather, another had been helping her stepfather to pour fish fertiliser into a mix. I know that he also applies 2,4-D with his mix.
>
> Searle 2000, p.2.

That children are being exposed to 2,4-D herbicide in Northland seems certain. The formulations used, those of butyl ester and ethylhexyl ester are volatile and reported to drift considerable distances: "our Area School was vapour-drifted from an aerial application of ethylhexyl ester over 1.3kms away" (Newman & Searle 2000, p.8).[34] The above account doesn't prove that the children were exposed to 2,4-D, or that even if they were it was the herbicide that caused these health effects. However, it seems wise that, if this account is presented along with, and following, numerous other complaints about the herbicide, the Pesticides Board acknowledges that there might be a problem and investigates further the exposure of children to 2,4-D in Northland.[35] Yet the Board accepted the recommendation of an "Expert Panel", that "there did not seem to be any reason to formally review the current registration status of 2,4-D and its salts and esters

[34] According to Newman & Searle (2000, p.11), in 1979 in Australia the use of high ester 2,4-D was restricted to fifty kilometres away from areas of commercial tomato growing and despite this measure damage to the tomatoes from 2,4-D still persisted. Newman & Searle cited Gilby, Scott, Ebell & Horne (1984). Also Cox (1999b, p.15) reported 2,4-D drifting five to ten miles from Colorado wheat fields, up to fifty miles from the site of application in Washington, and up to fifty kilometres in Natal, South Africa. Cox cited Westra & Schwartz 1989; Robinson & Fox 1978; Sandmann, de Beer & van Dyk 1991; de Beer, Smit & van Dyk 1992.

[35] The Pesticide Board received 359 submissions opposing 2,4-D in 1996. In 2000 it received twenty-one submissions and two petitions opposing it, and twenty-seven from Northland farmers supporting its continued use.

in New Zealand at this time" (Pesticides Board 2000, p.6).[36] No comment was made by the experts on Searle's observations.

Moore took issue with the way in which anecdotal evidence is systematically dismissed by the scientific enterprise:

> What originally evolved into a strictly defended sincere belief that science could not be science with the inclusion of anecdotes, has evolved further to the point that convenience may be outpacing belief in science's official refusal of anecdotal evidence: there is a measure of manipulation and control involved on the part of powers that be when they reject external ideas threatening to the status quo and may, if admitted, rock the boat a bit. Dismissing AE [anecdotal evidence] as a valid part of a methodology by labelling it derogatorily (as in "anecdotalism", or "merely anecdotal") is a convenient way to obscure its usefulness and avoid giving credence to a threatening theory that may be largely dependent on AE (such as holistic medicine).
>
> Moore 1999, p.143.

Such also is the case with multiple chemical sensitivity. Moore noted that effects reported in anecdotal evidence are frequently dismissed as "hysteria, misinterpretation, or irrelevant", with funding being given to official investigations that take years to complete and frequently can only provide inconclusive results that are interpreted as exonerating the government or corporation involved. Moore (1999, p.224-7) provided a number of examples of situations in which anecdotal reports were ignored or denied for many years, or obfuscated by years of study, yet eventually were confirmed. These include tobacco and silicon breast implants. They also include two cases that are relevant to pesticides. The first is that of the use of Agent Orange in Vietnam, in which the U.S. government initially flatly denied that the effects suffered by the exposed servicemen were in any way related to the herbicides. Now the effects are at least in part acknowledged, although liability is still contested (Moore 1999, p.224). The second situation relates to the more recent Gulf War, following which servicemen, again, suffered ill health, reportedly as a result of exposure to a combination of several chemical agents (e.g. Bell *et al*. 1995; Miller & Mitzel 1995; Fiedler *et al*. 1996; Bartha *et al*. 1999). Once again the anecdotal reports were, and continue to be, denied because of a lack of scientific understanding of how the effects could have occurred. That thousands of veterans suffer chronic ill health is recognized by a number of researchers, but liability for these effects is avoided by shutting out the anecdotal evidence and waiting for proof

[36] The Expert Panel consisted of two toxicologists, one of whom is the Registrar of Pesticides, an occupational health specialist, and a scientist from ERMA.

from positivist science. Hence the responsible agency, in this case the US government, is able to avoid what would probably amount to millions of dollars of compensation claims and political embarrassment.

Anecdotal evidence brings people face to face with the reality of the consequences of their actions, an uncomfortable situation for many and thus one to be avoided if possible. It is far easier to take refuge behind risk assessments and assert that the risks from a pesticide are insignificant or acceptable, than to acknowledge that school children may be getting sick from it, and even suffering life-long damage to their health and development. If 2,4-D causes endocrine disruption, as has been suggested (Krimsky 2000, p.121), then the people who are responsible for small school children being exposed to 2,4-D may have difficulty acknowledging that evidence.[37] The country as a whole might prefer self-deception to acknowledging the anecdotal evidence that indicates pesticides might be more harmful than they had been led to believe, and with which they had passively, or actively, colluded for many years.

> Although rational reconstructions and scientific articles work well within the normal science paradigm that has dominated the science project throughout this century, we cannot count on them for accounts of the whole truth. As it stands now, who and what in the science world are we to believe? If we espouse a holistic philosophy and value unrestricted holistic accounts regarding nature, and if we seek the fullest picture of the truth, using anecdotal evidence in science would not lead us any further from the truth than science already has, and it might allow us to come closer to the whole truth that we are lacking in a reductionistic, rationally reconstructed science.
>
> Moore 1999, p.184-5.

Neither toxicology nor anecdotal evidence can afford a complete view of the risks from pesticides. Even taken together they cannot. The safety or otherwise of pesticides can never be completely proved or disproved. As Sternberg said:

> . . . the recognition that total understanding will always elude us is itself a sign of wisdom.
>
> Sternberg 1990, p.3.

But if wisdom and anecdotal evidence are used to augment toxicology, then there is a greater chance that a truer reflection of reality might be achieved in pesticide policy. It was anecdotal evidence, according to Moore (1999, p.201), that led Rachel Carson to

[37] Listed as a probable endocrine-affecting chemical by the Illinois Environmental Protection Agency, 1997, *Endocrine disruptors strategy*, p.3.

study the effects of pesticides, that study culminating in her book *Silent Spring* which provided a holistic picture of the issue and lead to major changes in the way pesticides are regarded and used. That evidence was a letter from a friend informing her of the steady disappearance, over a period of several years, of the birds from her backyard.

Moore (1999) was only one of many writers who have challenged the right of science to "its accepted reputation as the key to all of life's problems", in noting that it does not in fact have "the cognitive nor the moral competency to define and legitimate ultimate realities or truths" (p.202).[38] Nasira Habib made similar comments, although couched in a wider epistemological framework:

> Knowledge is not the privilege of the professional thinkers and scientists but it has its roots in the social, cultural, political and economic processes. We need to learn from life along with its emotional and spiritual dimensions.
>
> Habib 2000, p.30.[39]

Habib was, in this instance, referring to the vital importance of women's knowledge in agriculture, particularly in Pakistan, a contribution often made invisible because of the centuries old, carefully constructed dominance of male-determined rationality over women's ways of knowing.[40] But Habib's comments would equally well apply to the woman school teacher's observations of the effect of 2,4-D on school children versus the rationally constructed mathematical risk assessment which asserts that it is safe to spray 2,4-D on farm land. Certainly it is not difficult to see that toxicological risk assessment does not have the cognitive nor moral competency to define the reality of pesticides and their effects on the ecosystem, including humans.

Moore's concluding comment brings together this section on wisdom with the findings of Chapter 5, in which it was argued that ecological rationality and an ecocentric ethic provide the logical basis for ethical pesticide policy:

> Our world has serious problems affecting not just the environment, but societies and individuals as well, everywhere. What is it that links all the world's problems? I submit that the answer can be found in the

[38] Moore referred to a claim by Latour and Woolgar (1986) that "there are no 'a priori reasons for supposing that scientists' practice is any more rational than that of outsiders'", noting that they "base their argument on the premise that scientific activity is just one social arena in which knowledge is constructed" (Moore 1999, p.179).

[39] Nasira Habib, Director, Khoj Research and Publishing, Lahore, Pakistan.

[40] Women's accumulated knowledge and wisdom has been relentlessly dismissed as old wives tales, witchcraft, gossip, and other such terms (Code 1991, p.68, cited in Moore 1999, p.202).

> paucity of three basic ingredients: wisdom, respect for the Earth, and a holistic view, each of which is interrelated with the others.
>
> Moore 1999, p.299.

Criteria for acceptable anecdotal evidence

As Moore pointed out, the use of criteria, against which anecdotal evidence can be assessed, may assist in establishing the credibility of this form of information. Improved credibility would certainly assist with the acceptance of anecdotal evidence in pesticide policy decision processes. Moore (1999, p.268-70) posited the following criteria for identifying acceptable anecdotal evidence that could be incorporated into western medicine and other scientific fields, noting that they have in common an "implicit acknowledgement of holistic connection" (p.268):

1. *Plausibility/common sense*
   This will determine a person's immediate intuitive reaction to the evidence, which can then serve as an initial screening process, although the ultimate assessment will depend on wise and holistic thinking. The source of the information plays a role, but plausibility does not rest solely on the credibility of the source.

2. *Precautionary principle*
   This includes assessing the relative risk of not accepting the evidence as opposed to the risk of accepting it. What is the risk of not accepting the schoolteacher's evidence about 2,4-D?

3. *Ethical and social responsibility*
   This requires determining if the evidence is guided by, or compatible with, ethical and social responsibility. Would accepting the anecdotal evidence reflect a higher degree of social responsibility than accepting only the toxicological data that contradicts it? This criterion may require reassigning the burden to proof to the pesticide rather than the public where it currently rests.

4. *Systematic information gathering*
   There should be some degree of systematization in the generation and/or interpretation of information. The observations should be deliberate and focussed even if they are informal.

5. *Multiple cases*
   The more cases that show similarity of content and context, the more credible the evidence. However, single cases may also be acceptable.

6. *Intuition*
   Intuition, or 'gut feeling', can be used along with other criteria to determine whether or not anecdotal evidence should be included.

7. *Word-of-mouth*
   Moore included word of mouth recommendation regarding the effectiveness of holistic medical therapies as a type of anecdotal evidence. This criterion might apply to knowledge regarding alternatives to pesticides, a subject to be explored later in this chapter.

8. *Testing*
   This criterion again comes into play when assessing the merit of alternatives to pesticides. Moore referred to three ways of testing: that of the conventional scientific approach, that of tradition over a long period of time such as the use of neem leaves by Indian farmers, in this instance, and that of informal empirical testing, such as on-farm trials.

It is not suggested here that these criteria are necessarily the final word in deciding what information should and should not be included in pesticide policy. They do, however, provide a useful guideline and many of these can be seen to be met by the case studies of both anecdotal evidence and lay epidemiology provided later in this chapter. Caution is urged in the application of these criteria. They should be used flexibly and wisely. They should be used simultaneously, i.e. all of them applied together as a system of checks and balances, rather than one lifted out and used alone to exclude a piece of information. One of the problems with providing a definitive set of criteria is that they can be used in too rigorous a manner for political expediency and to reject information that would otherwise be useful. Criterion 4, that of systematic information gathering, is a case in point. Whilst this is a good criterion and can be seen to be very important in lay epidemiology, it could potentially be used to exclude useful information that has arisen from casual observation or accumulated experience over a period of time. Examples of this type of information are those provided by the Northland school teacher's observations of the effects of 2,4-D (Searle 2000), and those of the doctors whose observations of patients' sensitivity to glyphosate were reported in the Auckland City Weed Management Policy (Davis *et al.* 1998). Common sense will go a long way in determining what is or is not valid information.

Support from post-normal science

Support for the inclusion of anecdotal evidence in pesticide policy can also be found in the work of Silvio Funtowicz and Jerome Ravetz.[41] They assigned the term "post-normal science" to what they termed the "wild areas" of science, the problems in science where "typically facts are uncertain, values in dispute, stakes high, and decisions urgent" (1992, p.253). Although decisions in pesticide policy may not be regarded as urgent, the other qualifying characteristics of post-normal science are certainly present. In fact, in the practice of regulatory toxicology, the decisions usually are urgent because they are driven by the economic imperative of a chemical corporate's desire for registration of a product often backed up by timelines to which adherence is required by law.[42] Post-normal science has its place in those areas of "ineradicable uncertainties in a value-laden context" (Funtowicz & Ravetz 1992, p.254), which no amount of increasingly sophisticated mathematical tools can ever resolve. Instead what is required, according to Funtowicz and Ravetz, is "a dialogue among stakeholders in a problem, regardless of their formal qualifications or affiliations" (1992, p.254).

However, Funtowicz and Ravetz take the discussion one step further: it becomes not simply a matter of rival rationalities that need to be worked through, but additionally, or instead, a need for "extended peer community review" as a means of quality assurance of the experts' work (1992, p.254). They see the need for quality assurance as arising, not as a challenge to the technical expertise of the scientists, but rather as a need to question the quality of the societal and ethical aspects of their work. Their thesis is that, because of the uncertainties inherent in the scientific material and the value assumptions involved, the experts themselves become amateurs. As has been demonstrated in Chapters 3, 4 and 5, toxicology fits this description.

The particular contribution of the community to post-normal science is seen by Funtowicz and Ravetz (1992) as that of the anecdotal evidence and statistics that are gathered—what they refer to as "extended facts" (p.254). These include "anecdotes circulated verbally" (p.271) and edited collections of materials prepared for public use by citizen groups. The authors also drew attention to community knowledge of local conditions and a "keen awareness of how general principles are realized in their

[41] Funtowicz and Ravetz are co-directors of the Research Methods Consultancy, London.

[42] For example Clause 59 of the HSNO Act 1996 specifies that ERMA must notify the public of applications for registration of hazardous substances or new organisms within ten working days of receipt of those applications, allow thirty working days for public submissions, fix a hearing date within twenty-five working days of close of submissions, give the applicant ten working days notice of this hearing, and then publicly notify their decision on the application not later than fifteen working days after the conclusion of the hearing.

backyards" (p.271). This amalgamating of science and public experience in the policy debate was regarded by Funtowicz and Ravetz (1992) as the "democratisation of science" (p.254-5), an evolving of science in response to the changing needs of humanity countering what Harry Otway (1992) referred to as the anti-democratic nature of the defining of problems in such a way as to make them the province of experts (p.219).

Funtowicz and Ravetz used Kuhn's classical theory about the maturity of science and scientific revolutions to argue the case for post-normal science:

> We are now familiar with the cases where a body of scientific or technological puzzle solving is radically flawed or nearly vacuous when viewed from the outside, while the community of practitioners have by some means maintained a consensus that all is well or will be soon. It is difficult for a layperson to argue effectively that this or that field of academic science is not as mature as its proponents claim. But when the responsible experts are unable to produce a class of environmental models that predict reliably, or an experimental practice that protects sentient beings, or an epidemiology that identifies environmentally caused illnesses without protracted political and legal struggles, then by default we are in the realm of post-normal science, and we need an extension of the peer community for the exercise of quality assurance.
>
> Funtowicz & Ravetz 1992, p.267.

Such is the case, it is contended, with pesticide toxicology. When members of the community assert that they are ill from exposure to low levels of pesticides, and increasingly the medical experts support that view, but the toxicologists refuse to accept it because it does not fit with their models, then a situation of post-normal science exists, and it is time for community experience to be incorporated into a new policy model.

Funtowicz and Ravetz (1992) saw the needs of post-normal science, which include considerations of well-being and humanity, being addressed by a "more pluralistic strategy of inquiry" (p.268) in which power is shared more equitably among those who are affected by the consequences, in this case of pesticides. The issue of who should be involved in making pesticide policy decisions is the subject of the next chapter. Mention is made of it here simply because the issues of what knowledge should be used and how it is used are inextricably linked.

Lay experts

Much of the investigation into the importance of lay knowledge comes from the field of medical sociology (e.g. Brown 1992, Williams & Popay 1994, Popay & Williams 1996, Moore 1999) rather than from a perspective of pesticides. Yet it has the same basis from the lay perspective. What differentiates the lay approach from the professional medical approach is a focus on illness rather than disease process, according to Brown (1992, p.267). Similarly, what differentiates the lay approach from that of the professional in the arena of pesticides is again a focus on illness rather than the causative process. Thus the findings of medical sociology have a direct bearing on the issue of lay knowledge of pesticides. That branch of sociology has "long been concerned" about the differences between professional and lay ways of knowing (Brown 1992, p.267), but it appears to be "only recently, and painfully slowly" (Popay & Williams 1996, p.760) that lay 'beliefs' have begun to be accorded the status of knowledge. So far this appears to be happening only in the social sciences and humanities (Popay & Williams 1996, p.760).

Popay and Williams (1996) argued for the recognition of this lay knowledge as expertise within the public health model. Since pesticide exposure issues are issues of public health, as well as environmental health, the argument can be extended to pesticide policy. They argue that lay experts, although lacking formal accreditation, should be accorded recognition on the basis of relevant extensive experience, "much as are some senior academics, professionals and managers in the world of work" (Popay & Williams 1996, p.760). To back their argument they provide evidence of the role of lay knowledge in identifying the relationship between health problems experienced by communities and exposure to toxic wastes, of workers knowledge in identifying casual relationships between their working environment and patterns of disease, and of women in identifying the iatrogenic effects of drugs such as stilbesterol (Popay & Williams 1996, p.761-2). Brown (1992, p.273) also credited the lay knowledge as encompassed by the women's health and occupational health movements as uncovering the problems caused by Agent Orange, asbestos, pesticides, unnecessary hysterectomies, sterilization abuse, and black lung.[43] He drew attention to the access lay people have to data that is inaccessible to scientists, especially those people who live at risk of toxic hazards, and the frequency with which knowledge about community and workplace hazards over the last two decades has stemmed from lay observation (Brown 1992, p.270).[44] In describing lay knowledge, Williams and Popay referred to it as the "privilege of experience", a description that appears to originate with Adorno (1973, p.40, cited in Williams & Popay 1994, p.135).

[43] Brown cited Berman 1977; Rodriguez-Tria 1984; Scott 1988; Smith 1981.
[44] Brown cited Edelstein 1988; Freudenburg 1984; Frumkin & Kantrowitz 1987.

Popay and Williams (1996, p.762) referred also to the growing evidence of the power of lay knowledge in predicting future health experiences at the individual level, thus potentially providing an early warning system of serious problems yet to come. They also warn that, although the significance of lay knowledge has been established within social sciences to some extent, it is still accorded inferior status, even within these disciplines, let alone within the 'hard' science disciplines. For to acknowledge the relevance of lay knowledge, which is often qualitative, would threaten the dominance of quantitative and statistical methodologies and shift the ownership and control of knowledge away from professional experts (Popay & Williams 1996, p.762).

The same authors had previously described some of the social characteristics of lay knowledge. They referred to key themes that had emerged from the research of sociologists in this area. They found that lay knowledge of health and illness is "logically consistent and coherent" (Williams & Popay 1994, p.122) even where it differs from that generally accepted by the experts. It holds together different aspects of a person's experience of the onset, course and effects of illness in an attempt to make sense of causality in a holistic way. Not surprisingly, therefore, the knowledge is in a sense biographical, a "narrative reconstruction of the relationship" (Williams & Popay 1994, p.122) between the illness and the person's life as a whole. Again, not surprisingly, this leads to another main theme, that lay knowledge is culturally framed within certain belief systems, is representative of the discourses upon which it draws and thus is representative of ideas that are general in society. Thus lay knowledge is described by the authors as being "both personal and social knowledge" (Williams & Popay 1994, p.122).

Popay and Williams (1996, p.764,766) have taken the argument for including lay experiences in policy one step further by identifying this experience not only as knowledge, but also as expertise, thus elevating it to the position that is normally occupied only by scientists or other academically accredited individuals. They argue that policy makers ignore lay knowledge at their peril, that there is a need for professional experts and lay experts to begin to work together. They reject the criticism of this more democratic approach to knowledge as opening the door to postmodernist popularism, that to accept lay expertise means that 'anything goes' in terms of knowledge, on the grounds that most knowledge is relational rather than universal. This should not be interpreted as their rejection of postmodernism, as an earlier work described lay knowledge as post modern because of its emphasis on context and its openness to "variation, difference and local significance" (Williams & Popay 1994, p.123). The criticism that anything goes can be addressed by the introduction and judicious use

of defining criteria for acceptability, such as those posited by Moore for anecdotal evidence, and described earlier in this chapter.

The arguments put forward by Popay and Williams with respect to lay expertise clearly relate to pesticide policy as much as to any other public health policy. How this expertise should be incorporated into pesticide policy will be discussed in the next chapter. For now, it is important to acknowledge that expertise and to acknowledge the experts. These experts may be individual members of the community who observe life around them, such as the Northland schoolteacher, Joanne Searle, referred to previously in this chapter. More often they will be found within non-governmental organizations which have a firm grassroots, community basis. Much of this expertise, it is contended, lies with the knowledge of activists who, often through the pain borne out of their own experiences, or from knowledge derived from a broad, holistic approach to life, join together to form organizations or gravitate to existing organizations within which they can work to achieve a recognition of their knowledge at a policy level. In the pesticides arena, much of this expertise lies with the Pesticide Action Network regional groups that span the world and their hundreds of partner organizations, whose experience in community participatory research will be illustrated later. Many of these organizations include academic and professional experts—professors, scientists, doctors—as well as labourers, housewives, farmers and other community members. An example within New Zealand of a grass-roots organization that evolved out of community experience is that of the Toxins Awareness Group, an organization formed by people who had been poisoned by pesticides and experienced ongoing health problems, often as multiple chemical sensitivity. For fifteen years they have struggled to bring to public attention, especially that of policy-makers, the problems associated with ongoing exposure to low levels of pesticides (Watts 1994, p.15). Existing organizations to which people with experience or concern about the effects of pesticides have been drawn include the Soil & Health Association of New Zealand and Friends of the Earth. Each of these three organizations harbours a wealth of expertise about the impacts of pesticides on human health and the environment within New Zealand. Each of them struggles to gain, but seldom achieves, recognition of this expertise within the policy context. Only rarely is this struggle successful and the knowledge accorded at least some status. Such an occasion was the development of Auckland City's Weed Management Policy, which is described below.

A case study involving anecdotal evidence and lay expertise: Auckland City Weed Management Policy

Strictly speaking, this is a weed management policy rather than a pesticide policy. However, the stimulus for the development of the policy was the community concern about ongoing use of herbicides in public areas and the ensuing risk to public health (Davis *et al.* 1998, p.1). The policy has two broad aspects to it. The first aspect is the improved management of weeds that are damaging to the natural and built environments, and the second is the management of these weeds in a manner that is "environmentally, socially and economically sustainable" (Davis *et al.* 1998, p.2). Out of this arose the policy statement that "herbicides shall only be used where there is no alternative" (p.3). In the process of reaching this policy conclusion, a range of alternative methods of weed management were assessed for various situations (p.73-8), the methods by which herbicides can be used were reviewed (p.76-7), and the potential effects of herbicides on health and the environment were scrutinized (p.84-95, Appendix 7).

It is in this last area that the provision of anecdotal evidence occurred. Because of the manner in which herbicides were used by Auckland City, it was concluded that most public exposure was likely to be that of repeated low level doses through inhalation of drift or through skin contact and that, as a result, "the issue of chemical sensitivity is of particular importance" (Davis *et al*. 1998, p.86). Thus, in addition to reviewing the literature on the subject, the policy development process also included questioning registered general medical practitioners who "were understood to have some experience in treating chemical sensitivity, and hence could provide an informed opinion" (p.87). The doctors selected were largely those suggested by the Toxins Awareness Group, a community-based organization consisting largely of people adversely affected by pesticides and which participated in the policy development process through the Weed Management Consultative Group. Further suggestions were made by other chemically sensitive people and by the doctors themselves.

Letters were sent to the twenty-seven selected medical practitioners requesting their opinion on the subject of chemical sensitivity, the letter specifically seeking comment on exposure to glyphosate/Roundup as that was the herbicide most commonly used by Auckland City and hence the one to which the public was most likely to be exposed (Davis *et al.* 1998, p.90). Of the twenty-seven doctors contacted, fourteen responded. One of the fourteen expressed the opinion that Roundup is "a safe spray when used sensibly" and he/she had not seen patients effected by it (1998, p.93). One confined her/his comments to the biological insecticide *Bacillus thuringiensis* kurstaki, and these comments were omitted from the policy report as they were considered not to be relevant. The remaining twelve all expressed concern about herbicide use, with eleven

of them referring directly to patients that suffered adverse effects after exposure to sprays. Seven of the doctors implicated glyphosate or Roundup in the adverse effects. The doctors' comments were drawn from specific case studies of their own and from general observations of their practice. Examples of these are given below:

> Dr A provides the following symptom pictures for some of his patients, all of whom are claimed to have responded positively to treatment for exposure to [Roundup] GII:
>
> 1 Vomiting, diarrhoea, elevated temperature, slept very long hours for a week wanting only water for 4 days, personality change to that of a "tyrant"; ill for 4 months.
>
> 2 Cramps in feet, dizziness, vomiting, migraine, diarrhoea for 3 days, weak; ill for 4 weeks.
>
> 3 Tired, frequent waking during night, night sweats, sore tonsular glands, watery discharge from sinuses, "achey burning" joints, tender gall bladder, nausea, "background thickness to her thinking"; ill for one month.
>
> 4 "Gunk" in back of nose, tight muscles top of back, shoulders and up into head, headache, fatigue, restless legs at night; ill for 3 weeks.
>
> 5 Chest pains, discomfort in head and neck, pressure in bladder and bowel during night, loss of appetite, weight loss, gastric reflux, "prickly feelings throughout body", raised blood pressure; ill six months plus.
>
> 6 Sudden onset palpitations, restlessness, clammy tingling hands, diarrhoea, marked hunger ("had to eat to feel normal").
>
> Davis *et al*. 1998, p.91.

> I have several patients suffering from the condition of "Multiple Chemical Sensitivity". This is an "accepted medical diagnosis" and very hard to treat. The symptoms are characterised by extreme fatigue and pain in muscle groups. This is caused by exposure to agricultural sprays, including glyphosate. For this reason I consider glyphosate spraying in areas exposed to the public to be an unnecessary health hazard.
>
> Davis *et al*. 1998, p.93.

It is not possible to determine how much effect the inclusion of this anecdotal evidence had on the final decision by Auckland City Council to adopt the policy, and in the process opt for increasing expenditure on roadside weed control so that non-chemical methods could be used instead of herbicides. Clearly, however, the implications for public health and community opposition to herbicide use would have been important factors in that decision. The attitude towards the inclusion of anecdotal evidence was

not unanimously supportive. A chemical residue analyst, who was a member of the Weed Management Consultative Group that closely monitored the development of the policy, was strongly opposed to its inclusion. He stated that:

> Information regarding health effects has not been substantiated or validated. Opinions from a biased and skewed sample of anonymous doctors have no basis.
>
> Dawson undated, p.1.

His comments are important for they reflect the general scientific attitude towards anecdotal information, in which nothing short of double-blind trials would satisfy the call for information to be substantiated and validated. Such trials cannot ethically be carried out. Thus, policy making has to move forward using the best information that it can obtain. The doctors were not anonymous, but their names were withheld from the final document at the City Council's request according to the project manager Bryan Gould in 1998.[45] The charge that the sample was biased and skewed implies that there was a pretence of random sampling aimed at achieving a balanced view. In fact, such an approach would not have achieved the purpose of the exercise, which was to gather information on the effects of herbicides as they were being experienced by doctors and their patients. Clearly, asking doctors who have no knowledge of, or experience in the treatment of, chemical sensitivity to express their opinions on the subject would not have shed any real light on the situation. Rather it would be more likely to further muddy the waters though expression of uninformed bias.

The final judgement perhaps should rest on how well the resulting policy reflects the needs of the community involved. The weeds are still being controlled, there has been a significant reduction in complaints to the Council regarding herbicides and regarding the level of weed control, according to information provided to Auckland City's Weed Management Group by Parks Officer Jim Doidge in July 2000. There appears to have been no more stories in the local newspapers on the subject, indicating that the community is at peace with the outcome of the policy.[46]

6.2.3 Lay epidemiology

Both of the examples of anecdotal evidence that have been used so far, that of the school teacher's experience of the effects of 2,4-D on her pupils, and that of medical

[45] Personal communication by Gould to the author.

[46] The author and members of Toxins Awareness Group have monitored the local newspapers since the adoption of the policy.

practitioners experience of the effects of glyphosate on patients, are examples of informal anecdotal evidence. However, the process of lay epidemiology takes anecdotal evidence one step further and offers a more formal process that is likely to be more readily accepted into pesticide policy.[47] This comment does not imply that the informal approaches should be excluded. Indeed, it is contended that they should and must be fed into the policy process, and an example has been provided of the success of such an approach. But it may also be useful to involve a more formal process where this is practicable, although care should be taken not to waste valuable funding and community resources trying to emulate the 'experts'. According to Andrew Watterson (1999a), their "sophisticated epidemiological techniques . . . are often flawed and inconclusive, incapable of proving one way or another whether groups of pesticides increase ill-health" (p.11).[48] Watterson (1999b) provided evidence of just such a problem with a series of epidemiological studies designed to investigate the link between pesticide exposure and reproductive effects on women farmers in Indonesia. The outcome of the studies was inconclusive for reasons that included difficulty in establishing exposures, ensuring a valid control group for comparison, and ensuring adequate numbers to generate results that have statistical significance.

Lay epidemiology is increasingly finding favour in writings about public health research (Popay & Williams 1996), and about environmental health issues (Watterson 1994, 2000). It is defined as "the process by which lay persons gather statistics and other information, and also direct and marshal knowledge and resources of experts in order to understand the epidemiology of diseases" (Brown 1992, p.269).

There is a broad spectrum of approaches to lay epidemiology, ranging from those that approach 'scientific' epidemiology to those that approach anecdotal evidence. In the first instance, this may involve participation of the communities concerned in a 'scientific' epidemiological study, which uses the usual formal methodology but involves the community throughout the process, including jointly developing protocols, selecting criteria for interpreting the results, overseeing the research and communicating the results (Watterson 1994, p.271-2; Popay & Williams 1996, p.764). In this model the researcher retains the role of expert, but facilitates the use of her/his expertise in a manner that is defined by the community concerned (Loewenson, Laurell & Hogstedt

[47] Brown (1992) used the term 'popular' epidemiology in place of 'lay' epidemiology. However, the latter is used here as it is consistent with the previous usage of lay to describe assessment of risk, and because it is less likely to create bias in the context of policy language than is the term 'popular'.
[48] Andrew Watterson, Director of the Centre for Occupational and Environmental Health, De Montfort University, Leicester, UK.

1999, p.243). At the other end of the spectrum is lay or community initiation and 'ownership' of the study, with or without the involvement of 'expert' epidemiologists, and which slides into community participatory research.

Whichever end of the spectrum a lay epidemiology exercise rests, it must involve the workforce or community concerned. It should be essentially "non-expertist, subjective and collective in nature" (Scott-Samuel 1989, cited in Watterson 1994, p.271). Those involved should work *for* the community rather than *on* the community (Watterson 1994, p.271). Another important aspect of lay epidemiology is that it is geared, not only to elucidating the nature of health and environmental problems for policy purposes, but also to imparting information to the communities involved, particularly about the hazards they may face and the avoidance of those hazards (Watterson 1994, p.217). Thus the participatory research approach "conceptualizes the production of knowledge as itself the outcome of social relations" (Loewenson *et al.* 1999, p.243), and the exercise becomes educative and empowering rather than merely extractive. Brown (1992) took this analysis one step further and pointed out that lay epidemiology is not only risk detecting, but often also solution seeking (p.269). It tends to emphasize "social structural factors as part of the casual chain" (p.269), and often involves social movements and political advocacy as the community's "lack of power compels them to mobilize mostly in public rather than scientific spheres" (p.278).

At this point it is probable that the supporters of positivist science as the proper basis of decision-making will cry foul, and lay charges of non-objectivity and bias. Such charges need to be considered in the light of the information already presented on objectivity, subjectivity, the involvement of corporate interests, and the general bias towards technological enthusiasm in toxicological risk assessment, and on the need to replace Cartesian dualism in knowledge with a more holistic, pluralistic approach. It also needs to be considered in the light of the rights of communities to knowledge about potential risks that they face and to seek solutions to those problems, which, it is contended, should be a fundamental right in a democratic society.

An example of lay epidemiology is given by Watterson (2000, p.6) as that of the Vinatex study. In this study ex-workers organized, planned and partially implemented a study of current workers exposed to PVC, in order to track a range of health effects possibly linked to workplace exposures to vinyl chloride monomer, a gas used in the manufacture of PVC. The workers, in conjunction with a non-governmental organization, provided questionnaires modelled on those used by government departments and international agencies. They also conducted the interviews and

gathered data. The results were analyzed by a university in conjunction with the ex-workers. The outcome of the study raised major questions about under-estimates of the ill effects of exposure to vinyl chloride monomer.

Many of the other examples of lay epidemiology given in the literature also relate to factory workers (e.g. Loewenson *et al*. 1999, p.239-49), and to toxic waste (e.g. Brown 1992; Williams & Popay 1994), rather than exposure to pesticides. There are, however, a few examples of lay epidemiology relating to pesticides, one of which was recently carried out by the University Sains Malaysia in conjunction with Pesticide Action Network Asia and the Pacific. The study concluded that some of the sprayers surveyed experienced low cholinesterase levels "as a result of exposure to the pesticides" (Majid, Ibrahim, Abu & Razak 1999, p.61). It also presented the following self-reported symptoms and frequency of occurrence among seventy-two women pesticide sprayers employed in rubber and palm oil plantations:

> . . . fatigue (86 per cent), back pains (76.4 per cent), giddiness (56.9 per cent), difficulty in breathing (47.2 per cent), skin problems (47.2 per cent), nausea (45.8 per cent), eye irritation (44.4 per cent), headache (43.1 per cent), tight feeling of the chest (40.3 per cent) and swelling (38.9 per cent).
>
> Majid *et al*. 1999, p.59.

In addition, there are excellent examples of the use of the more informal community participatory research approach in the area of pesticides.

Community participatory research: studies by Pesticide Action Network Asia and the Pacific

Community participatory research is similar to lay epidemiology, but does not usually involve the same level of formal methodology or recognized professional experts. The approach involves identifying community perspectives, and recognizing and using the knowledge and experience of the community. The knowledge used tends to be broadly holistic and contextual. Such research often involves studying subjective symptoms and may result in qualitative rather than quantitative data (Watterson 2000, p.5).

An example of community participatory research into pesticides is that of the study of women and pesticides carried out by the non-governmental network organization, Pesticide Action Network Asia and the Pacific, in collaboration with some of its network partners. Eight countries in Asia were included in the study carried out between 1991 and 1998: Bangladesh, India, Indonesia, Korea, Malaysia, Pakistan, the Philippines and

Sri Lanka. The studies, all carried out in conjunction with members of the communities concerned, were designed to elucidate the nature of the problems faced by women in Asia with respect to their use of, and exposure to, pesticides. At the same time, and in the nature of the participatory approach referred to previously, the studies also sought to impart to the communities information regarding the potential problems of the pesticides they were exposed to, and the tools to make their own decisions about future exposure. More than 2,500 farmers and workers, mostly women, were interviewed through the community groups.

The research revealed not only significant adverse health effects resulting from this exposure, but also the "invisibility and marginalization of women's suffering with pesticide use" (Rengam 1999, p.2). The studies provided vital information on a range of policy issues relating to pesticide use:

- Exposure through spraying: in Malaysia there were about 30,000 women pesticide sprayers in the plantation sector alone, many of whom sprayed pesticides every day. Sore eyes, skin rashes, "burnt fingernails" were found to be some of the common health outcomes (Arumugam 1992, p.2):

  > I have been spraying pesticides for the past 20 years. I spray Gramoxone (paraquat) all the time. It is so strong that the odour makes me sick most of the time. In the beginning, I used to cry (tearing in my eyes from the strong fumes). Now my only main problem is nose bleed and chest pain. I also have bad stomach pain.
  >
  > Arumugam 1992, p.7.

- Exposure through picking crops, such as cotton in Pakistan, straight after spraying or even whilst the spraying is taking place. All the women surveyed in Pakistan picked cotton when pregnant and some carried their small children as well:

  > The complaints she has are: sneezing, vomiting, watery discharge from her nose, and pain in the ribs. She has taken medicines but to no avail. She feels better for 3 or 4 days and then the complaints recur. Her most painful complaint is that she cannot hold food in her stomach. She vomits food as soon as she consumes some.
  >
  > Habib 1996, p.80.

- Exposure through handling pesticides, in India:

> 21 women [of 100 workers questioned] reported that they used their bare hands for mixing the chemicals, 54 either used their hands or used sticks. . . . Because of scarcity of water in the area, only 21 per cent had facilities for immediate cleansing with water in the field. . . . The same hands that applied the pesticides were used without washing, for nursing babies at their breasts, washing vegetables, cooking the food, and feeding the children.
>
> Jayaprakash 1999, p.47.

- Exposure through food, in Sri Lanka:

> After finishing spraying, she plucks vegetables and chillies from the farm and uses them for cooking. She believed that once the spices were added and the vegetables were well cooked, the poison from the pesticides was removed.
>
> Fernando & Hewagalage 1999, p.18.

- Effects on farm animals, in Bangladesh:

> 'We know that pesticide is harmful. When we mix the pesticide in the water it expands like the boiling milk. It reacts in our body in the same way. We observe that the birds and animals are dying. We women do not want to use pesticide because we love our chicken, cows, goats like our family members'.
>
> Akhter 1999, p.14.[49]

- Suicide, in Bangladesh:

> Men do not bring the bottle of pesticide to their home, if they know that the wife is sentimental. She may take pesticide to kill herself if she is upset with the husband. . . . It is also found that the dealers do not sell to women. Because they think women are buying to kill themselves and then they will be in trouble.
>
> Akhter 1999, p.16.

A range of other problems were also identified: lack or inappropriateness of protective clothing, [50] inability to read label directions through illiteracy, recycling of pesticide containers to store food, drinking water and medicine, and many broader social

[49] Akhter quoted Jamila Khatun of Raini Karmakar para village in Bangladesh.

[50] Most pesticide application protective clothing is designed for temperate, western climates, and is simply too hot and uncomfortable to wear in tropical regions: "Veena does not wear the protective clothing provided by the plantation management. She feels hot and uncomfortable when using protective clothing in this climate" (Arumugam 1992, p.7).

problems such as women's powerlessness and dependency within an authoritarian male-dominated society and the implications this has for pesticide poisoning (Habib 1996, p.7-9).

The information gathered in these studies should be fed into the pesticide policy process. Does the risk assessment that determines Gramoxone to be safe to use include the fact that women will spray this chemical for twenty years, maybe every day of the week, without protective clothing? And the symptoms reported above? Does the risk assessment process that determines the safety of the cotton pesticides include the fact that pregnant women and small children will be sprayed with these pesticides, repeatedly? It must be acknowledged that the answer to these questions is simply 'no'. Much of the information obtained in these studies was qualitative and thus is largely ignored by the current pesticide policy paradigm. Exposure levels are mathematically calculated using models based on 'good agricultural practice', which involves conditions that bear no relationship to the reality of pesticide use as experienced by these women. It is evident that in Pakistan, India, Bangladesh, Sri Lanka and the other Asian countries in which these studies were carried out, women should be involved in the pesticide policy process, as well as in designing research programmes, to ensure that their knowledge is included and their needs are met.

Community participatory research such as this has never been carried out in New Zealand but it is contended that, if it were to be, the results could provide very vital information to the pesticide policy process. It is evident from the many submissions to the Pesticide Board in 1996 and 2000,[51] that there is a problem with the aerial spraying of 2,4-D in Northland. Many adverse health effects have been claimed. But the current policy paradigm based on causal links and toxicological data is powerless to understand the dimensions and ramifications of the problem. Formal epidemiological methods may make as little headway as was made with the Indonesian pesticides and reproductive problems study mentioned previously. However, a community participatory research project that seeks qualitative data, that acknowledges the experience and wisdom of the local community, may make a very valuable contribution.

In summary, it is contended that in order to apply the ethic of minimum harm to the environment it is essential to understand the harm that is caused both to humans and the ecosystem by all the available methods of pest management. The management method

[51] See footnote 35.

of pesticides has been used here to illustrate the need for a broader approach to admissible knowledge, but the same arguments apply also to assessing other pest management methods. It is contended that the reductionist toxicology methodology and the risk assessment process based on it do not adequately fulfil this task, because the positivist science approach prevents the incorporation of knowledge gained from wisdom and experience. It has also been argued that it is precisely this knowledge that is necessary for a holistic and contextual picture of the real effects of pesticides. Pesticide policy can gain greatly in its effectiveness and 'authenticity' by incorporating lay expertise and the knowledge provided by informal anecdotal evidence, community participatory research, and a more formal lay epidemiology approach. Although the evidence presented here applies almost entirely to human health effects, the same arguments apply also to effects on non-human nature, and it is contended that lay experts, often intimately associated with the environment within which they live and work, can provide vital knowledge on these effects.

6.2.4 Assessing methods of pest, weed, and disease management

The same arguments apply to the assessment of non-pesticide methods of pest management. It is not the intention to repeat here the previous exercise with respect to non-chemical methods, but a few comments are required. It must be noted that the same elements of wisdom apply, that is an holistic approach taking into account the contextual nature of the information, permitting intuition and emotion, and allowing for gender implications. A non-chemical method should not be taken in isolation and compared with a pesticide, for that is taking the thing out of context and thereby destroying its integrity. Non-pesticide management methods frequently depend on their context for their effectiveness. They can be found to be more effective within a systems approach that treats the whole, rather than the individual parts.

Much of the modern agricultural research that is undertaken still adheres to a mechanistic approach and fails to adequately incorporate the systems approach necessary to manage the agri-ecosystem with minimal harm. There is some information available on the effectiveness of non-pesticide methods from the technical experts who use positivist science. For example, the ENZA New Zealand manual on integrated fruit production contains several non-pesticide techniques derived from HortResearch scientists' trial work (ENZA 1997). However, it is contended that the majority of the knowledge about non-pesticide agricultural management can be termed lay expertise, and it can be found largely with farmer/gardening practitioners and the community-based organizations to which they belong. In New Zealand there is at least a sixty-year

history of the management of agricultural systems without chemical pesticides.[52] Some of the information deriving from this collective experience can be found in written form, for example in *Soil & Health*, the journal of the Soil & Health Association of NZ, *Harvests*, the journal of the Biodynamic Farming and Gardening Association of NZ, and various other publications and papers. Much of the information, however, has not yet been written down and can only be found in the minds and daily lives of those farmers practising these methods, according to Brendan Hoare.[53] The pesticide policy process needs to be able to incorporate this information as well as that of the positivist scientists in assessing the need for pesticides.

One way in which lay expertise can be harnessed in many countries is through the retrieval and application of what is known as indigenous knowledge, that is centuries of accumulated wisdom relating to the sustainable management of agricultural systems. New Zealand does not have such a wealth of indigenous farming knowledge to draw upon, for the indigenous Maori people were primarily hunters and gathers prior to the colonization of the country by Europeans who brought with them the industrial agricultural model. Hence most of the crops currently grown, with the exception of kumara and gourd, and livestock raised were not part of Maori indigenous knowledge systems. Nevertheless, the modern agricultural model, including pesticide policy, can benefit from Maori knowledge of the environment, the indigenous management systems in other countries, especially with respect to a biodiverse approach and soil enhancement practices, and the systematic efforts to foster, preserve and reintroduce this knowledge (e.g. Tjahjadi 1993; CIKS 1999; Habib 1999; Vijayalakshmi & Sridhar 2000).

In summary, the positivist science approach of current pesticide policy needs to yield to wisdom in the knowledge it incorporates in terms of effectiveness of non-pesticide management techniques, as well as with the effects of pesticides. Only in this way can the ethic of minimum harm to the environment be implemented. The most important aspect here is that a holistic approach is taken not a reductionist one, that a management practice is viewed in the context of the whole agri-ecosystem, not simply plucked aside and compared in controlled studies with a pesticide.

[52] In fact non-pesticide management methods date back to the beginning of agriculture in New Zealand, but this time period is provided as it is taken from the date of the establishment of the Soil & Health Association of NZ, then called the Humic Compost Club, in 1940, and the production of its journal which has systematically recorded the efforts to preserve the knowledge of non-pesticide agricultural and horticultural methods.

[53] Personal communication from Brendan Hoare, UNITEC, Department of Landscape and Plant Science, UNITEC, Auckland. 2000 July 17.

6.2.5 Weight-of-evidence decision-making

It should now be evident that, if the pesticide policy process is to incorporate knowledge other than positivist science, the traditional risk assessment process based on numerical estimates of probability of risk and associated estimations of benefit will no longer suffice. Instead, what is needed is a weight-of-evidence approach that takes into account all of the accumulated knowledge about potential hazards, environmental fate parameters, community experience, lay knowledge, social factors, least harmful methods of pest management, etc. Much of this information will be qualitative rather than quantitative and hence not amenable to the quantitative risk assessment procedure. Based on this information a determination is made about whether or not a particular pesticide should be registered, or whether or not a particular approach to other pesticides issues such as spray drift, aerial spraying, residues in groundwater etc, should be adopted. The outcome of a weight-of-evidence approach is not couched in terms of probable risk, or acceptable risk, or safety, but rather in terms of the best available information and society's needs and wishes. It does not require certainty about cause and effect such as is demanded by positivist science, but rather a weight of evidence that there is an effect, or a need or a value. This approach is sometimes used in risk assessment processes, but only in a limited way with respect to deciding about a risk posed by a pesticide based on toxicological and epidemiological data.

The weight-of-evidence approach is consistent with the precautionary principle (Tickner 1999, p.169), and with the principle of minimum harm. It is the approach that is consistent with community knowledge and with wisdom. The weight-of-evidence approach has the ability to accommodate a vastly increased range of values and knowledge types compared with the relatively reductionist approach of risk assessment. Where the risk assessment process permits or denies a singular pesticide, the weight-of-evidence process can determine whether or not there is a less hazardous alternative, and hence whether or not there is a necessity for the pesticide in the first place. Hence it can answer the very first question that needs to be asked, but which is overlooked by the risk assessment process: 'is this pesticide needed?'.

Conclusion

The second stage in developing ethical pesticide policy is that of determining what knowledge is admissible to that policy in order to implement the ecocentric approach that has been adopted, including the principle of minimum harm. In this chapter the

perceived objectivity of science as a criterion for selection has been challenged, as has the pretension of positivism to portray reality. The inability of positivist science-based policy to cope with the problem of endocrine disrupting pesticides illustrated the need to look beyond this approach to knowledge. Thus, it was argued, there is a need for wisdom to take its place in pesticide policy. Wisdom, it was revealed by Moore (1999), involves common sense, experience, intuition, emotion, context and holistic thinking, and can provide profound insight and broad foresight, exactly those qualities which are often used to discredit, not just lay knowledge, but especially women's ways of knowing. The language of technical rationality, warned Audrey Armour (1997), eschews personal knowledge, and discounts "insights and intuition borne of life experience" (p.45-6). Wisdom is thus excluded from positive science, but it can be found in the knowledge, experience and expertise of lay people. In this, and preceding chapters, the relationship between explanation and prediction with respect to pesticides has been shattered, opening the way for a much greater degree of flexibility in predicting and identifying harm. It is contended that wisdom should be admitted to the policy process as anecdotal evidence, as lay epidemiology, and as community participatory research. It should be used as an adjunct to, not a replacement for toxicological data and positive science, in a way that will help to broadening the understanding of the real effects of pesticides with the community and the ecosystem. This knowledge needs to encompass not only the adverse effects of pesticides, but also the effectiveness of non-pesticide methods of managing pests, weeds and diseases in the agri-ecosystem within a systems management approach. It needs to include assessment of the social impacts of pesticides, some of which were highlighted by the reports from Asia: who benefits, at whose expense, and whose interests are served?

Lay knowledge, as wisdom, provides two major challenges to positivist science: it challenges its objectivity and it challenges its authority to determine the way in which problems should be defined in the policy arena. Thus, it not only provides a body of information that can assist in the making of wise policy decisions that incorporate a holistic approach, but it also challenges the institutional power of expert knowledge and of experts. It is not surprising that the inclusion of lay expertise in policy decisions is strongly rejected by experts who have an interest in protecting their own careers, those experts usually attempting to vindicate their claims of superior objectivity by taking recourse in technical knowledge. Such a claim, it has been shown, cannot be substantiated and must be understood in terms of the political nature of institutional power, and vested interest in exerting control over expert knowledge (Williams & Popay 1994, p.119-20,123-4,134). Shifting the boundaries of knowledge, the social basis of

epistemology, will encounter resistance from powerful interest groups (Ong 1996, p.52). The next stage in the development of ethical policy, therefore, is a challenge to the experts' control over the pesticide policy process, and thus the next chapter will address the question of who should be making the policy decisions in an ethical pesticide policy. If shifting the boundaries of knowledge is likely to meet strong resistance, shifting the boundaries of who should be decision-makers in the policy process is likely to meet even stronger resistance from those whose power is in question.

Finally, it should be reiterated that the use of science in the pesticide policy process is not being rejected here and replaced with lay knowledge. Rather it is scientism—"the belief that natural science and only natural science has the answer" (Connelly & Smith 1999, p.119)—that is rejected. The belief is well encapsulated by the following quote:

> In its eagerness to exalt the truths of science, empiricism has, crudely and blindly, undermined other modes of knowing, including public judgement. . . . American culture grossly overvalues the importance of information as a form of knowledge and undervalues the importance of cultivating good judgement. It assumes, falsely, that good information automatically leads to good judgement.
>
> Yankelovich 1991, cited in Charnley 2000, p.10.

In ethical pesticide policy, it is scientism that is rejected, not science. The knowledge derived from natural science takes its place alongside knowledge derived from lay experience and learning. Such an approach, whilst unusual in pesticides policy generally, did briefly find support in New Zealand's draft biodiversity strategy, which specified that one of the principles for managing biodiversity is that:

> All biodiversity management actions should be based on the best and most current information and knowledge available, including traditional Māori knowledge (mātauranga), local experience, and the results of scientific research and monitoring.
>
> DoC & MfE 1998, p.23.

Unfortunately, this support did not survive into the final strategy (DoC & MfE 2000, p.13).

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Chapter 7 Who Decides?

Introduction

Drawing together the threads of this thesis, it is now evident that the traditional process of weighting numerical risks against benefits, and then having technical experts determine what is an acceptable level of risk for society to bear from each pesticide, will no longer suffice. It will no longer suffice because it has been shown to be rationally and ethically wanting. It is rationally inadequate because its flawed methodological processes fail to properly reflect the reality of human experience, particularly that of constant exposure to low doses of chemical mixtures, and they fail to reflect the ecological effects arising from the interconnectedness of nature. Risk assessment is also rationally lacking because it is based on an unproven assumption that pesticides are necessary. It is ethically inadequate because it ignores the intrinsic values of non-human nature—of ecosystems, species, and individuals. And it is ethically inadequate because it ignores the worldviews, values and rights of arguably the majority of members of society. It ignores issues of distributive justice and the wider social implications of pesticide policy. It ignores the expertise and experience of the community. It completely ignores the numerous issues surrounding gender: differences in attitude and social values, effects caused by pesticides, and knowledge and experience, all of which have been pointed to throughout this thesis.

In an ethical pesticide policy, the technocentric/anthropocentric/mechanistic approach of current policy would be replaced by an ecocentric approach. The policy process must now admit an understanding of the ecological rationality of the interconnectedness of all things in the environment including humans, an ethic of minimum harm to the environment involving the replacement of hazardous pesticides by less hazardous chemicals and non-pesticide management methods, and the wisdom inherent in lay expertise and community experience, much of which is qualitative rather than quantitative. It must also admit social and cultural values as elements of social justice, which again cannot be expressed in the quantitative terms of technical assessment, but which are an important part of an ecocentric ethic based on a partnership approach, as was discussed in Chapter 5, section 5.3.1. The policy decisions need to systematically include issues of democracy, aesthetics, spiritual values, cultural values, uncertainty, and sense of community (O'Brien 2000, p.143). They need to involve fundamental conceptions of morality, equity, justice, sovereignty, property rights and duties, and what constitutes quality of life (Rappaport 1996, p.65). They

need to consider who gains and loses from various alternatives, ensuring that those who reap the benefits also face the costs and risks of, and liability for, their actions—a reversal of the current situation where the risks from pesticides are borne by neighbours, consumers, the environment, and by future generations, but the benefits accrue to the manufacturers, and arguably sometimes the users.[1]

In this last chapter, attention is now turned to one more important ingredient of the policy process that, it is contended, is vital in determining whether or not an ethical pesticide policy can be developed and implemented: who it is that makes the policy decisions. For, as Brunk *et al.* (1998) pointed out, the constitution of the Review Board in the alachlor case was pivotal in determining the framework for decision-making and the ultimate decision it made.[2] The Board consisted largely of scientists who naturally brought their scientific expertise to bear upon the problem, which had the effect of making them "less responsive to rights claims" (p.127), social values and community experience.

The current pesticide policy decision-makers

In a neo-liberal democracy such as New Zealand's public policy decisions are normally taken by bureaucrats. This is an approach common to pesticide policy in a number of other liberal democracies such as the United States and the UK. However, a different approach has been followed with pesticides in New Zealand. Whilst that part of pesticide policy that is contained in legislation has been developed by bureaucrats and then modified and signed off by the legislature, the translation of the legislation into day-to-day policy and its implementation has been carried out by a statutory authority. This authority, the Pesticides Board, has consisted of bureaucrats and interest groups largely representing the interests of pesticide manufactures and users. The Pesticides Act 1979 (section 12) requires the Board to consist of ten people, excluding the chair. Of these ten members, four must be nominated by government ministries, one by the pesticide manufactures lobby group AGCARM, one by retailers of pesticides, and five by various

[1] Benefit to the users is a mute point, for although pesticides may sometimes, but not always, provide short term economic benefit, this profit is not usually balanced against damage to health and medium- to long-term damage to the agri-ecosystem. An example of short-term economic loss to producers through use of pesticides is provided by returns to apple growers in New Zealand in the 1999-2000 season. Conventional export growers using an array of chemical pesticides sold their apples on average at $8.25 per carton, which represented an approximate loss of $1 per carton. Some export growers producing under organic management were able to achieve returns of $35-$50 per carton (Clearwater 2000). Also, Walker, Liebman & Pease (1995) of the University of California, Berkeley provided a useful summary of pesticide-induced disruptions of the agricultural ecosystem.

[2] The alachlor case was described in Chapter 3, footnote 7.

farming sector groups. Traditionally, one of the ministry positions has been given to a representative of environmental interest groups. This statutory authority is eventually to be replaced by ERMA once that part of the HSNO Act 1996 relating to pesticides becomes operational, as reported in Chapter 1, footnote 8. All the members of ERMA are either scientists or corporate directors, one of the latter being a past chairman of the New Zealand Chemical Industries Council (ERMA 1999a, p.2). Under the Pesticides Act regime there was no requirement for public consultation or submissions on policy matters, and the only avenue for community experience and values was via the one member representing environmental interest groups. Under the HSNO regime that avenue is removed and replaced with a statuary requirement for a public submission process. However, it will be argued here that neither model is adequate for an ethical pesticide policy process.

The proposed policy group: an outline

It will be argued in this last chapter that decisions regarding pesticides can no longer be regarded as the domain of technical experts. Pesticide policy must become a very much more democratic exercise, one that reflects ecological rationality and social justice rather than merely 'sound science' and the agenda of the technocratic optimists. With the challenge to the supremacy of positivist science and technical expertise issued in the previous chapter, comes also the challenge to the role of the professional experts in decision-making. They are no longer the keepers of all the information that is required in decision-making, although they must still contribute valuable scientific information. The decisions that are to be taken will be taken on behalf of society and must reflect society's values and needs, and ecological values and needs, and must incorporate knowledge other than that which represents the views of only technical optimists. It will be argued that, in order for pesticide policy to serve society, the decision-makers should be mainly drawn from those sectors of society that are most affected by that policy, namely the public and the users of pesticides. It will be argued, too, that non-human nature should be represented at the decision-making table. The target of public policy should be the public, in this case particularly the communities of people who wish to use pesticides, those who are affected by them, and the non-human ecological 'community'. Therefore these groups are the focus for the policy and thus should be at the centre of its development. Logically, improved decisions involving risks can be achieved by involving in the decision-making the parties who bear the consequences of the decisions. Just how these interests should be represented, and the process involved, will be elaborated upon later. Enabling appropriate public participation is a means of ensuring that public values, including gender- and culture-related differences, are

reflected in the policy. There is a gathering momentum in western countries such as the USA and Europe, and to a lesser extent New Zealand, for increased public participation in policy-making, but there is also considerable opposition to public participation and this too will be canvassed.

The two aspects of pesticide policy

However, before embarking on that discussion it is important to broaden again the view of pesticide policy. Much of the material in this thesis has related to the assessment of pesticides, that part of the pesticide policy process that confers or denies registration on the grounds of 'acceptable' or 'unacceptable' risk. At this stage it must be recalled that the registration process is only one subset, albeit usually the most prominent one, of pesticide policy. In some countries, such as New Zealand, this part of the policy achieves great prominence as there is little public discussion of any other aspects of the policy, and it comes to be perceived as the sum of the policy. But pesticide policy is much larger than this one process and encompasses broader aspects of agriculture, public health, environmental integrity, and of the course the social issues that have been referred to throughout this thesis. Hence, in referring to decision-making in this chapter it is not only the registration process that is intended. As was discussed in Chapter 1, some of the most important aspects of a public policy are the setting of the initial agenda, the establishment of the goals and objectives of the policy, the framing of the questions that need to be asked, and answered. These aspects of the pesticide policy process are of even greater importance than the actual registration/assessment part, and the following discussion on who should be the decision-makers refers to the wider policy process that incorporates all these facets of public policy, but also includes the ongoing role of registration. Thus, there are two areas of decision-making with respect to pesticide policy. The first is the establishment of the broader framework of the policy, with occasional adjustments over the years to suit the evolving needs of society and the evolving understanding of both pesticides and pest management. The second is the ongoing operational aspects including, but not limited to, registration, and control of use.

7.1 The case for less public participation

There are a number of the writers who have expressed a view that the problems relating to science and risk management in public policy are caused by too much, rather than too little, public involvement. Hence, they have put forward suggestions for improvements

in policy decision-making, essentially through the reduction of public input. A brief review of the rationale underlying some of these opinions is provided below.

7.1.1 Maintaining science's cultural authority

Dale Jamieson (1996), in his discourse on uncertainty, pointed to the way forward for public policy as that of bringing science into closer contact with policy, reducing the "autonomy" (p.42) of science and making the policy process more technocratic. He asserted, without providing evidence to back his assertion, that "all parties to various conflicts have an interest in maintaining scientific authority", which he referred to as a "unique cultural authority" (p.40). Yet, at the same time, he acknowledged that "many of our problems about risk are deeply cultural and cannot be overcome simply by the application of more and better science" (p.35). Jamieson made a very interesting point about the vested interest in maintaining scientific authority:

> Political actors of whatever ideological outlook have an interest in preserving scientific authority because science can provide a rationalization for decisions that are made on other grounds. When a policy decision can be presented as dictated by science, it is a way for a decision-maker to evade responsibility for his or her choice. A decision backed by science can be viewed as implied by the nature of things, not as a decision for which a leader should be held accountable.
>
> Jamieson 1996, p.40.

It is contended that this is precisely what happens when science becomes too closely involved in policy making and exactly this type of misuse of science can be avoided by more clearly addressing the value and cultural issues involved in the decision-making, by incorporating knowledge gained by community experience, and by including people other than technical experts in the decision-making. Although Jamieson was not actually suggesting a reduction in public participation in the policy process, nevertheless that is the likely effect of making it more technocratic and of bringing science and policy closer together.

In her report entitled *Democratic Science*, Gail Charnley also addressed the issue of maintaining the integrity of science.[3] Her report was commissioned by the American Industrial Health Council and the American Chemistry Council, two industry lobby groups "concerned" that the trend towards greater involvement of the public in decision-making, through stakeholder processes, was compromising "the integrity and importance of science" (Charnley 2000, p.1). They were "concerned" about "whether

[3] Charnley, HealthRisk Strategies, Washington, D.C.

stakeholders have the ability to respect and preserve the roles that science can play in informing decisions" (p.2). Interestingly, Charnley concluded that "while some perceive that science suffers in the hands of stakeholders, it is difficult to evaluate that perception objectively using the currently available data base" (p.16). Charnley was not able to provide evidence to support the assertions of those who had commissioned the report. In fact, after examining a number of case studies, "the report concludes that scientific integrity is maintained and its credibility is assured when stakeholders are involved in deciding how science is used" (p.3). It must be acknowledged that, although Charnley mentioned the need to incorporate other knowledge (p.10), she placed emphasis only on considering "science and social values" (p.3) by balancing "the scientists' facts and the public's judgement" (p.11), generally through use of scientific experts that all stakeholders agree to. Thus, she excluded lay knowledge, in favour of which this thesis has argued. However, that emphasis needs to be seen from the perspective that her brief concerned the protection of the integrity of science rather than the development of an ethical policy process.

Positivist Gio Batta Gori inadvertently provided a view of the defence of science as the only basis of policy-making taken to its logical conclusion: that of no pesticide policy at all. He based his defence on the argument that the concept of policy fairness demands that policies be based on truth coupled with the libertarian view that policy should be preventive, not punitive. The result is that policy should not be made in the absence of factual evidence (Gori 1996, p.S4,S6). He correctly pointed out that:

> In reality, the interpretation of animal and epidemiological data depends on a set of logically unjustifiable assumptions that have reduced real life complexities to arbitrarily simplified models. Inevitably, generalizations based on reductionist models are not value-neutral but a matter of opinion and therefore the instrument of special interest.
>
> Gori 1996, p.S5-6.

Gori's argument leads to only one logical outcome: if decisions can only be made on the basis of factual evidence but the toxicology is "a matter of opinion", there can be no decisions. This deduction meshes with Gori's view that hazards should only be regulated when they are known and should not be pre-guessed, a view that is inconsistent with ethical pesticide policy, as has been demonstrated in Chapters 3, 4 and 5.

7.1.2 Insulating the bureaucracy from the public

Another argument for decreasing public involvement comes from those who believe that decision-making belongs with the bureaucracy and that it should be isolated from public pressure. This position is epitomized by the views expressed by Justice Stephen Breyer of the US Supreme Court. Breyer (1993), in his attempt to break "the vicious circle" between the public perception of risks from chemicals, the politicians 'overreaction', and the regulators conservatism, advocated an improved bureaucracy which would be "insulated from political and public pressures" (p.60-1). His proposal revolved around elevating the bureaucracy to a position of greater prestige. He expressed the opinion that the bureaucracy would then provide a new career path for civil servants who are "honest, talented and qualified administrators" (p.59), people who are highly qualified (p.74) experts in science, risk analysis, economics, and administration (p.62) and who will be attracted by increased authority, prestige, and potential accomplishment (p.74). Their task would be to "bring a degree of uniformity and rationality to decision-making in highly technical areas" (p.61). They would achieve higher quality analysis, build models, and use sensitivity analysis. They "might" consider special groups of people that have been identified by "medical research" as genetically predisposed to cancer from certain chemicals, offering them "special counselling" including how to avoid the carcinogens so that society can continue to use the chemicals concerned (p.67). He also saw a single "rationalizing" group of administrators as able to "facilitate democratic *control*" [emphasis added] (p.73). The exercising of authority and respect for authoritative decisions appear to rank high in Justice Breyer's view (p.63), an attitude that can be described as hierarchical and elitist. This particular worldview was shown in Chapter 2, section 2.2.3, to be more prevalent amongst males than females, and although common amongst toxicologists, does not represent the worldviews of the general public. Breyer (1993) acknowledged that such exclusion of the public might be interpreted as being undemocratic, but defends his position by the comment that "representative democracy is not undemocratic" (p.75): as long as there is still some degree of Congressional power over the regulators, democracy still exists. Interestingly, when referring to public participation he described it as "the perception of public participation" (p.63), which, it is contended, is an accurate description of the one-sided consultation via submissions that commonly passes for participation in New Zealand, as will be discussed in section 7.3.3. Breyer's interpretation of the meaning of democracy is only one of several, all of which will be visited briefly, in section 7.2.2.

Justice Breyer also made passing mention of the notion that the loss of public trust in government institutions over recent decades might be reversed though greater public

participation. However, he appeared to place greater weight on successful bureaucratic accomplishment as a means of restoring trust and public confidence (Breyer 1993, p.63).

Breyer countered several other objections that may be raised to his plan, but he did not address the issues of the role of values in risk-based decision-making. The experts he has selected to make decisions are likely to represent a relatively small range of value systems. They would be highly educated in the disciplines of science, law, economics and administration, and it was demonstrated in Chapter 2 that their views of risk are likely to be significantly different from those of the majority of the population. They are likely to be motivated by prestige and power rather than egalitarianism, for Breyer made a direct appeal to those qualities. As Kunreuther and Slovic (1996, p.123) asserted, trying to resolve risk and value conflicts with more science will likely exacerbate the problem. Even though Breyer (1993) acknowledged the "uncertainties, knowledge gaps, default assumptions, [and] guesses" (p.48) involved in risk assessment, he still reported risk data as if it were factual (p.11-9) and ignored ecological rationality.

Breyer quite clearly believed that chemicals are good for society, that the risk is worth it and some people should carry a risk so that others can benefit. These views underlie his characterizing of regulatory assessment as conservative, and his view that the 100-fold safety factor that is used in place of knowledge is a safety first cannon that leads to conservative risk-averse decisions (Breyer 1993, p.43). Yet, Breyer acknowledged neither his value system nor the influence of the regulator's value systems on their risk assessments. Neither did he acknowledge the expertise, gained by experience, which exists amongst members of the communities exposed to pesticides.

7.1.3 Let the corporates slug it out in the market

Richard Zeckhauser and Kip Viscusi (1996) stated an opinion that the public's assessments are irrational and that government policy "should not mirror citizens' irrationalities" (p.154).[4] They recommended, instead, that government should promote the decisions people would make "if they understood risks correctly" (p.154), that is presumably according to technological and anthropocentric rationality. They see the process as best left to corporates and individuals to slug out via the market, with government as referee in relation to inaccurately perceived risks and externalities via the establishment of property rights and the enforcement of contracts (p.145). Such a view assumes perfect knowledge of the risks involved, which as has be demonstrated

[4] Zeckhauser, Professor of Political Economy, Harvard University; Viscusi, Professor of Economics, Duke University.

throughout this thesis is not a reality for technical experts let alone private citizens. It assumes that technical experts have the same worldview and range of factors involved in risk assessment as does the lay assessor, which has also been shown to be a false assumption. It portrays an anthropocentric, utilitarian approach to the environment in which exploitation and damage are acceptable up to the point where they interfere with human benefit. This rationale was rejected in Chapter 5.

7.1.4 Controlling the public debate

Roger Noll (1996) expressed the view that there needs to be increased resources for regulatory agencies so that they can "control the public debate in risk policy" (p.166).[5] This they would achieve by the identification of risks and "effective responses" (p.166) to them, and the communication of these findings to the public. His rationale for this stance is that citizens have difficulty "in knowing whether either those who cause risks or those who are responsible for mitigating them are acting in the citizens' interest" (p.166). He argued that both citizens and elected officials "do not have sufficient information to identify the precise nature of a risk", and hence they must delegate the responsibility to the "experts" (p.168). He was concerned about incoherence in risk regulation that results from pressure exerted on elected officials by "a mobilized group of fearful citizens" (p.173). Hence more discipline is needed in the system. Noll acknowledged that citizens could only rely on regulators to act in their best interest if the regulators were altruists and the citizens were in agreement about the level of protection about risk. Thus, he acknowledged also that it is perfectly rational for citizens to interpret the failure to protect them from risk as a failure of regulation. Noll argued, correctly it is contended, that the solution to this problem is to inject "better knowledge and judgement" into policy decisions (p.174). However, he assumed this better knowledge and judgement can only come from regulatory agencies, presumably backed by positivist science, and not from the community itself. As has been argued in the previous chapter, it is precisely the lay experts within the community that can provide that better knowledge and judgement.

7.2 The case for greater public participation

A far greater number of writers have recognised that the fundamental problems with the way in which risk assessment is carried out, and the policy processes that

[5] Roger Noll, Professor of Public Policy, Stamford University.

incorporate this technique into decision-making, can only be solved by greater involvement of the public.

7.2.1 Incorporation of societal values

In particular, there is a recognition that societal values are not well encompassed by technical decision-making, which incorporates its own particular set of technological values.[6] This problem was revealed in Chapter 2, with discussion of the effects of worldview, education, socio-economic status, gender and race on the attitude towards risk and the difference between toxicologists' social views and those of the majority of society. Hence, one of the most compelling reasons given for public involvement in pesticide policy is that expressed by Virginia Sharpe (1996), in which she "places" herself with Dreyfus, Maclean and Shrader-Frechette, "all of whom argue that values are inherent to risk assessment and that they should be the subject of public deliberation, not methodological eradication" (p.269).[7] Howard Latin also made an appeal to societal values:

> We challenge this view that only scientific perspectives should dominate the risk assessment process. Risk assessment is too important and too uncertain to be left exclusively to risk assessors. . . Instead, we should examine a range of social policy criteria that could be incorporated in the risk assessment process after appropriate public discussion.
>
> Latin 1988, p.304-5. [8]

Public policy, it should be recalled, was described in Chapter 1 as "a continuous process of institutionalizing values" (Considine 1994, p.52). Should those values be only those of the technological experts, or should they incorporate the values of wider society?[9] As has been illustrated throughout this thesis, and particularly in Chapter 6, section 6.2.1, where the relationship between pesticides and violence against women in Bangladesh was described (Akhter 1999, p.27-8), pesticide policy encompasses broad societal issues. Failure to recognize these issues is a failure to act ethically, thus it can be assumed that an

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[6] For example Shrader-Frechette 1985, 1991; Latin 1988; Gough 1990; Mayo & Hollander 1991; Krimsky & Golding 1992; von Winterfeldt 1992; MfE undated; Cothern 1996; Keeney 1996; Kunreuther & Slovic 1996; Sharpe 1996; Slovic 1997; Brunk *et al*. 1998; Loewenson *et al*. 1999.

[7] Sharpe, Departments of Medicine and Philosophy, Georgetown University, Washington, D.C.

[8] Latin, John J. Francis Scholar, Rutgers School of Law at Newark, New Jersey.

[9] Even the science-based Cartagena Protocol on Biosafety acknowledges the importance of the "socio-economic impacts of living modified organisms [genetic modification], especially on indigenous and local communities": Article 26, Cartagena Protocol on Biosafety to the Convention on Biological Diversity, which was finalized and adopted in Montreal, 29 Jan 2000, at an extraordinary meeting of the Conference of the Parties to the United Nations Convention on Biological Diversity (www.biodiv.org/biosafe/Protocol/Background.html, accessed 14 December 2000).

ethical pesticide policy will address broader social ramifications of pesticide use. The question then becomes one of whether or not the technical experts and the bureaucrats can be assumed to be the best judges of social values and societal issues. It is the author's experience that the current New Zealand pesticide policy decision-makers, the Pesticides Board, have difficulty in recognizing the existence of broader social issues, and are at a loss to know how to deal with even those that are recognised, such as the significant monetary cost of herbicide drift onto horticultural crops. There is no reason to assume, and experience to counter the assumption, that technical experts and bureaucrats have special competency in making judgements about societal values and issues.

7.2.2 Democracy, equity, and justice

If determining the acceptability of risks associated with chemical products is, as Audrey Armour (1997) asserted, "first and foremost an exercise in social discourse, not scientific method" (p.54), then her second premise is a logical consequence: "science and experts should not be placed at the center of the political debate" (p.54).[10] Shrader-Frechette made much the same point several years earlier:

> Determining when a risk evaluation is rational is as much the prerogative of the people as of the experts. Science need not co-opt democracy.
>
> Shrader-Freycette 1991, p.13.

Thus, the second appeal is to democracy, in addition to the inclusion of social values:

> In a democracy, it normally goes without saying that decisions affecting all citizens should be made democratically. Decisions that involve scientific and technical complexity stand as grand exceptions to the rule.
>
> Sclove & Scammell 1999, p.252-3.

The problem is that the required social discourse referred to above is stifled by the impoverished communications that result from the bureaucratized exercise of power and deference to expertise, especially that associated with technological rationality (Armour 1997, p.54). Large sections of society are systematically excluded (Connelly & Smith 1999, p.60). The result, frequently, is the marginalization of those whose lives are most affected by the decisions that are taken (Armour 1997, p.54) and, as Plumwood (1998) noted, there is a serious problem with the rationality of any system that allows those who have least access to political voice and decision-making power to be also those who

[10] Armour, Associate Professor , Faculty of Environmental Studies, York University, Ontario.

suffer the worst consequences of the decisions (p.573). Plumwood saw the reversal of this situation as a necessary condition of ecological rationality.

The issue of improved public participation is thus one of the need to achieve greater equity and control in risk decision-making processes through community oversight. The equity argument also relates to gender issues: where there are significant gender differences the pesticide decision-making process should reflect those differences. However, it does not do so in New Zealand: currently the Pesticides Board consists of ten men but only two women, one of whom is the environmental interest group representative and the other the Chairperson (MAF 2000a, p.4).

Shrader-Frechette appealed to medical ethics in her argument in favour of a risk management process that involved democratic community participation:

> A physician is ethically justified in imposing a possibly nontherapeutic risk on patients only after they or their representatives have given free, informed consent. Even if the patients are not experts and have faulty risk perceptions, the doctor cannot make the consent decision for them.
>
> Shrader-Frechette 1991, p.86.

She then extended the concept of informed consent to encompass technological risks stating that, since society "sanctions the equitable imposition of unavoidable harm", society requires a method of equitable distribution of risks where those risks are unavoidable (Shrader-Frechette 1991, p.87):

> Rational societal decisionmaking requires an ethical rule that takes account of the fairness of the allocational *process* (for instance, whether potential victims exercise free, informed consent to the risk), not merely the *outcomes*.
>
> Shrader-Frechette 1991, p.106.

Williams and Popay, also working from a public health perspective, drew attention to the World Health Organization's view regarding the need for community participation in health issues:

> It is the basic tenet of the health for all philosophy that people must be given the knowledge and influence to ensure that health developments in communities are made not only for, but also with and by the people.
>
> WHO 1985, p.11, cited in Williams & Popay 1994, p.124.

They pointed out that working 'with people' means enabling participation by lay people in decision-making, as well as taking their knowledge seriously (Williams & Popay 1994, p.124).

Thus the calls for improved democracy involve the concepts of social discourse, equity, fairness, free informed consent, rationality, working with people, and lay participation in decision-making.

Whence cometh the call?

Social movements have been advocating more direct involvement in political decision-making since the early 1920s, according to Thomas Webler and Ortwin Renn (1995, p.18), but it was not until the emergence of the environmental movements of the 1970s that this advocacy began to become effective.[11] Notions of participatory democracy have come primarily from the feminist and environmental movements, particularly from the confluence of these two, ecofeminism (Carter 1993), from Green political theory (e.g. Saward 1993; Dobson 1990, 1998; Doherty & de Geus 1996) and the environmental justice movement (e.g. Rowe 1999; Plumwood 1998; Shrader-Frechette 1991, 1994). The argument for distributive justice has grown out of the recognition of the socio-economic and racially skewed distribution of the adverse health impacts of environmentally damaging technologies. Hence, its proponents have emphasized the strengthening of interest group representation in systematically disadvantaged communities, empowerment of potential 'victims', and community right to know—in fact many of the things referred to in the previous chapter as outcomes of community participatory research. It seems that the issues of environment and democracy are inextricably linked. Greater democracy through public participation is seen as an important component of not only environmental justice, but also of the precautionary approach (Tickner 1999, p.175). According to Charnley, Robert F Kennedy Jr contended that the environmental movement and the laws it spawned gave us "true democracy in this country for the first time" (Kennedy 1998, cited in Charnley 2000, p.11).

Finally, Michael Jacobs (1999) asserted that participation in terms of the political involvement of all groups or stakeholders in society draws its "textual authority" (p.27) from *Agenda 21*, although the concept has since come to be seen as having substantive value of its own.[12] In that document participation was regarded primarily as a means to

[11] Webler, post-doctoral research associate with the Interdisciplinary Project on Risk and Safety at the Swiss Federal Institute of Technology, Zürich; Renn, Professor of Environmental Sociology, University of Stuttgart.
[12] Jacobs, General Secretary of the Fabian Society.

ensure sustainable development, although several writers have suggested that achieving environmental ends and public participation are not necessarily consistent with each other (e.g. Goodin 1992, p.168; Dobson 1990, p.26; Saward 1993, p.70-2). This concern will be explored later, in section 7.4.2, with respect to the expression of democracy in the proposal put forward in this chapter.

What of the future?

In conclusion, it seems very unlikely that public policy, especially that which involves environmental and human health issues such as pesticide policy, will back away from democracy in the near future, despite the desire for retreat into technical expertise that can be seen to issue from technological enthusiasts. The trend in many western democracies towards increased public involvement in risk decisions is encapsulated by Charnley's description of the USA's movement away from "the unilateral, technocratic, regulatory model of risk management decision making" and towards a more "inclusive and democratic" process, as one that reflects the "democratic ideal that people should be involved in their own governance" (Charnley 2000, p.4). Democratization, concluded John Dryzek (2000), is "largely (though not exclusively) a matter of the progressive recognition and inclusion of different groups in the political life of society" (p.113).[13] How this might best be achieved in ethical pesticide policy is discussed later in this chapter.

7.2.3 Trust

A third rationale for greater public involvement came from Paul Slovic (1997). He reported a study on the management of a nuclear power plant, which found the only event perceived to have any substantial impact on increasing trust by the community was the establishment of an advisory board of local citizens and environmentalists to monitor the plant, and with legal authority to shut it if they believed it to be unsafe (p.89-91). Slovic then stated the opinion that an improvement in society's trust in, and acceptance of, the decisions made about technological risks would follow from greater public participation. That participation, he said, must involve "deliberative decision-making" including negotiation, mediation, oversight committees and other forms of public participation" (Slovic 1997, p.95-6).

Slovic's opinion is supported by the results of attitudinal surveys carried out in New Zealand and elsewhere, and reported in Chapter 2, section 2.2.1. These surveys showed

[13] Dryzek, Professor of Political Science, University of Melbourne.

that trust by the New Zealand public, in matters relating to pesticides, was greatest for public interest groups, slightly ahead of that for the Ministry of Health, and least for the pesticide industry. On the issue of biotechnology, trust in the public authorities was significantly less than that of environmental or consumer groups, falling to a mere 5 percent of people having confidence in the authorities to tell the truth. These survey results are similar to those obtained in other countries where generally, but not always, public interest groups are more trusted than government authorities and pesticide or biotechnology companies.

Trust in the decision-makers is an important element in community acceptance and implementation of public policy, and lack of trust is likely to be expressed as ongoing conflict and societal distress, both of which an ethical pesticide policy should aim to minimize.

7.2.4 Wisdom

It was argued in the previous chapter that there is considerable expertise and wisdom in the lay community, and that pesticide policy would benefit from the inclusion of wisdom in the decision-making process. Wisdom, it was also argued involves common sense, experience, intuition, emotion, context and holistic thinking, and as such provides a challenge to the authority of positivist science. That challenge extends to the role of positivist scientists as decision-makers, as for example is the situation with ERMA. It is not rational to expect positivist scientists to be able to pay equal regard to those elements of wisdom described above that provide a direct challenge to their own professional and educational backgrounds. It is more rational to include in the decision-making body people who are better placed to understand the complexity and contextual nature of community experience, and it is contended that people drawn from the wider community can provide and help foster the necessary wisdom.

7.3 Approaches to public participation

It is contended that the arguments in favour of increased public participation in decisions relating to risk substantially outweigh those posited for decreasing public involvement. Thus, it is argued that the development of ethical pesticide policy must proceed on the basis of sufficient public participation. The question now becomes one of what is to be regarded as sufficient participation, and how this should take place. In order to answer those questions, a brief tour of democracy theory is first required. This is because of the

need to embed the decisions that will be made here within a theoretical basis and because, more pragmatically, there is significant ambiguity in the use of the term 'participation'. Toddi Steelman and William Ascher (1997) pointed out that public participation "means many different things to many different people" (p.72), spanning a spectrum from participation through voting in the electoral process, to binding direct policy-making by non-governmental representatives in which the latter formulate policy within structures overseen by selected or appointed officials.[14] In between these two ends of the range lie the more commonly used non-binding methods of involvement. Steelman and Ascher claimed that the proliferation of these modalities has caused "confusion over the purpose and intent of public input" (p.72) and over the role it is to play in the policy-making process. Public input can be regarded as "public expression of preferences" (p .4), which provides data for the policy makers, or it can "be conceived also as part of the process of the authoritative selection of policies" (p.74).

To even begin to discuss the various approaches to democracy in the limited space available here is a tall order, for as Robert Dahl (1998, p.3)[15] pointed out democracy has been the subject of discussion for more than twenty five hundred years, since the times of classical Greece and Rome, and there is still no agreement on some of the fundamental principles.[16] The literature on the subject is immense and any review of it beyond the scope of this thesis. The following description of some aspects of democracy is necessarily brief and limited to only those aspects pertinent to the development of pesticide policy.

Webler and Renn (1995) referred to the two ends of the democratic scale as "elitist" and "egalitarian" (p.21), noting that the debate about public participation centres on these two competing approaches to democracy. The elitist interpretation of democracy, that which lies behind liberal democratic theory, holds that the populace has the right to determine which of the competing elites will govern, but not to determine the substance of the political decisions. This approach is typified by Justice Breyer's proposal reported earlier in this chapter. The egalitarian approach, however, asserts that "each citizen should be able to co-determine political decisions that affect his or her livelihood" (Webler & Renn 1995, p.21). In between these lie the pluralistic approach in which political elites seek to have their decisions legitimated by key interest groups, and the neo-corporatist approach

[14] Steelman, Graduate School of Public Affairs, University of Colorado at Denver; Ascher, Sanford Institute of Public Policy, Duke University, Durham (NC).
[15] Dahl, Sterling Professor of Political Science at Yale University.
[16] The term democracy is derived from the Greek terms *demos*, the people, and *kratos*, to rule (Dahl 1998, p.11).

in which key actors such as industry, unions and technical associations negotiate acceptable paths behind closed doors (Webler & Renn 1995, p.21). The current approach to pesticide policy in New Zealand can best be characterised as a form of neo-corporatism towards the elitist end of the scale: the policy is determined by government and implemented by negotiation with the pesticide industry and farmer groups, with token involvement of public interest groups as a legitimation of the decisions. The approach will change with the full implementation of the HSNO Act, which will add a smidgen of the egalitarian in the form of provision for public submissions, but with a concomitant reduction in egalitarianism by removing public interest groups from the actual decision-making process.

It is more common in the field of democracy theory, however, to refer to the two general approaches to democracy as 'representative' or 'constitutional' democracy on the one hand, and 'extended' democracy on the other, in which the first roughly correlates with Webler and Renn's elitist interpretation and the second with their egalitarian interpretation. Until recently liberal democracy could be characterised as being largely dominated by the representative interpretation, which holds that elected politicians represent the people of the country and their wishes and needs, and that democracy operates by way of a set of laws agreed to by the elected representatives. Brunk *et al.*'s (1998) comment in their report on the Canadian alachlor case, that "arguably the most qualified spokesperson for the public was the Minister of Agriculture" (p.118), is representative of this position.

However, this model of democracy is gradually being replaced by models of extended democracy, commonly referred to as discursive/deliberative and participatory approaches. These are sometimes recognized as two distinct but overlapping approaches to democracy, although they are sometimes rolled into one (e.g. Bohman 1996, p.27-32), or transposed. Renn, Webler and Wiedemann (1995, p.2), for example, used the term 'public participation' exclusively for forums for exchange of views to facilitate communication, and excluded any involvement of the public in direct binding policy approaches. In order to avoid any further confusion the term 'deliberative democracy' will be used here to encompass those models of public engagement that are based on non-binding, advisory and communicative modalities. The terms 'participatory democracy', and 'direct public participation', will be reserved for those approaches that involve public interest groups and community members in direct binding decision-making in policy processes. The proposal in this thesis is one of direct public participation. However, the deliberative democracy approach will also be reviewed here, as it is currently the favoured approach in democracy theory, policy science and in

practice. The vast majority of the extended democracy processes that have been tried so far are the non-binding involvement methods that characterise recent moves to implement deliberative democracy. It will be shown why this approach is not the most appropriate for ethical pesticide policy development and implementation.

Whilst one aspect of extended democracy involves the issues of advice/opinion gathering versus direct participation in decision-making, there is a second very important aspect: that of the mode of involvement. There are generally three options: 'open-to-all' via submissions and public hearings, randomly selected citizens, or public interest group representation. The open-to-all and random selection approaches characterize deliberative democracy. Interest group representation characterizes participatory democracy as defined earlier, although it can also be found to a lesser extent in deliberative approaches. The proposal in this thesis is for interest group representation, supported by a wider open-to-all submission process. Both aspects of extended democracy will be analysed below, first in terms of the type of democracy and then in terms of the mode of involvement.

7.3.1 Deliberative democracy

John Dryzek (2000) noted that the theory of democracy took a turn towards discursive/deliberative democracy in the early 1990s (p.v). The two terms are used interchangeably, but common usage supports the term 'deliberative', although 'discursive' better portrays the methodology involved: that of discourse and communication between the various policy actors (Dryzek 2000, p.v). The term deliberative will be used in this thesis, although the emphasis on the underlying methodology of discourse is an important one and is reflected in virtually all of the models of public participation referred to here.

The essence of deliberative democracy is that "democratic legitimacy should be sought . . . in the ability of all individuals subject to a collective decision to engage in authentic deliberation about that decision" (Dryzek 2000, p.v). Deliberative democracy has come to represent a concern that democracy be substantive rather than merely symbolic, and "engaged by competent citizens" (Dryzek 2000, p.1). Eckersley made the same point in referring to the ideal communication community as being "made up of *all* those who are potentially affected by any proposed norm" (1999, p.26).

Deliberative democracy has emerged against a background of concern that the liberal democratic system fails to deliver the equity that is the promise of democracy and that is increasingly sought by many people in many countries. Dryzek illustrated a common

problem with liberal democracy by referring to the interest group pluralism model that has evolved under the US political system, and which is used to defend its constitutional liberalism system against calls for a greater public discourse. The interest group pluralism approach theoretically allows for many points of entry for interest groups into the political system. But, as Dryzek pointed out, this approach has failed to overcome the inequality between the voice of business and the voice of everyone else, caused by the privileged position business interests hold in policy deliberations. This privileged position arises from all governments' reliance on corporations "to carry out essential tasks in organising the economy, without which government itself could not function" (Dryzek 2000, p.18). Government's position, in turn, is strongly influenced by "extra-constitutional agents of distortion" that include "dominant discourses and ideologies, often intertwined with structural economic forces" (Dryzek 2000, p.21):

> In today's world, the most compelling of such forces emanate from the transnational political economy, imposing severe constraints on what is possible in terms of both the content of public policy *and* the degree of democracy that can be tolerated in the state's production of policy.
>
> Dryzek 2000, p.21.

Dryzek's comments are extremely important: it is vital to be cognisant of the privileged position business holds with government under standard policy arrangements, the influence of the transitional political economy, and how these factors affect the attainment of ethical pesticide policy. This issue will be raised again later in the defence of the proposed model and particularly with respect to the role of pesticide companies in policy development. Meanwhile, it is contended that the interest group approach should not be thrown out because of the problem of industry dominance identified by Dryzek and experienced with New Zealand's Pesticide Board, but rather that the policy group should be carefully structured to minimize this problem.

The thrust of deliberative democracy is that of wide public involvement in discourse, in deliberation about the issues of concern, and with the outcomes of that deliberation influencing policy-making. The intention is to provide the decision-makers with better knowledge of what it is that society wants and how it views particular problems, but also to encourage better understanding by citizens of the issues involved. The deliberative approach thus leaves aside the issue of the actual decision-makers, leaving this part of the process intact as a function of the bureaucracy, and restricting the role of the public to the expression of societal views. A number of models reflecting this intent have been proposed, utilised and evaluated over recent years, implementing in part the shift in the public involvement *ideal* noted by Robyn Cantor (1996) as that "from opportunities for

public comment to an emphasis on open and participatory processes" (p.143).[17] Some of these will be reviewed in section 7.3.3.

7.3.2 Direct binding participatory democracy

Whereas the thrust of deliberative democracy is wide public discourse on an issue with the outcome providing advice to the policy decision-makers, the thrust of participatory democracy is that members of the community are involved in actual binding decision-making. There are two distinct ways in which such participation can be mediated: by non-affiliated individual citizens or by citizens acting though organized community or public interest groups. The former approach is the main focus of the democracy theory literature, and discussion and examples are confined largely to community matters, and most recommendations for implementation are confined to the local or village level (e.g. Dasgupta & Maskin 1999, p.79; Held 1999, p.107; Dryzek 2000, p.25). In his recent book on deliberative democracy, Dryzek (2000) made only one reference to participatory democracy, in which he mentioned a process that proceeds "on a face-to-face basis in small communities" (p.25). It is also a major focus of participation within Green political theory, where it is linked with another Green argument: that of decentralisation of power structures (Doherty & de Geus 1996, p.1).

Examples of direct binding participatory approaches at a national policy level, which is the concern of this thesis, are uncommon. Where they do exist they involve public interest groups and have tended to be categorized as 'interest group pluralism' (Williams & Matheny 1995, p.29-33) rather than as participatory democracy. Hence this aspect of participatory democracy will be addressed in section 7.3.5.

The participatory approach to democracy can perhaps be characterised by what Anne Phillips (1995) referred to as the "politics of presence" as opposed to the "politics of ideas" (p.1).[18] Phillips' terminology was directed at participation in the electoral system, i.e. representative democracy, but her analysis holds good for decision-making at the bureaucratic level. It is a recognition of the view that "the mere insertion of ideas into the policy process does not suffice as a representation of disadvantaged groups", and the actors themselves should be included in the institutions of democracy to give "authentic voice to the exclusions and oppressions they have experienced" (Dryzek 2000, p.60). This proposition is strengthened by the finding, in the previous chapter, that community experience and lay expertise can add vital knowledge and wisdom to the pesticide policy

[17] Cantor, Program Director for decision, risk and management sciences, National Science Foundation.
[18] Phillips, Professor of Politics, London Guildhall University.

process. The procedural conditions listed by deliberative theorist Robert Dahl (1985) can be seen as important aspects of participatory democracy as well as deliberative democracy. These include equal, effective participation in the process of making decisions, equal opportunity to discover and validate reasons, final control by citizens over the agenda, and inclusiveness of all adult citizens, according to Bohman (1996, p.32).[19]

Finally, it would seem, at first glance, that support for the concept of direct participatory democracy can be found also in the policy literature, in what is termed postpositivist policy analysis and described by Dryzek and Torgerson (1993) as occupying "the intellectual high ground in the policy field" (p.132). But a note of warning is sounded by the authors' description of Fischer's (1993) merging of postpositivist policy analysis with the deliberative model of democracy, as that of "joining reason and democracy" (p.132). For Fischer's model of participation exhibits the same schism between expertise and citizenry as is found in positivist science and in the deliberative democracy approaches described earlier. Expertise is seen to lie squarely with experts and not to exist within the citizenry, a notion that was rejected in Chapter 6. A model that promises "the democratization of policy expertise" (Fischer 1993, p.165) eventually consigns lay expertise to the backwaters of policy decision-making, indeed ignoring it altogether as a valid repository of knowledge and wisdom. Likewise, the promise of "participatory policy analysis" (Fischer 1993, p.165) delivers up to the policy process only participatory research, carried out by technical experts with involvement from citizens.[20] It does not deliver direct participation in decision-making. In the event, then, it is really deliberative democracy that is involved.

It must be noted that direct participatory democracy has its detractors. They tend to regard it as an impossible ideal that places too great a demand on both the public and political institutions under current social conditions (Bohman 1996, p.30,237). They see the general public as politically irresponsible, 'primitive' and/or apathetic (Carter 1993, p.47), with a propensity for being excitable and hotheaded (Rescher 1999, p.305-6), and lacking reason (Dryzek & Torgerson 1993, p.128). Dryzek and Torgerson noted that:

[19] Inclusiveness of all adult citizens in fact occurs with neither deliberative nor participatory democracy, but is enhance by both approaches.

[20] This comment should NOT be read as denigrating participatory research. Such research has already been discussed in Chapter 6, where it was argued to be an important contributor to knowledge about pesticides and an invaluable method of empowering communities. Rather, the comment should be read in light of a failure to take the analysis one step further and include those empowered communities in the actual decision-making aspect of the policy process.

> Liberals from Locke to Hayek have, of course, always been attuned to the dangers of too much democracy, and especially its threats to liberal freedoms and the capitalist market.
>
> Dryzek & Torgerson 1993, p.130.

Another argument follows the line that there are not sufficient citizens with "the right consciousness" or experience in participatory decision-making (Carter 1993, p.48). Such might well be the situation if the case is argued in the extreme, that any citizen be plucked from obscurity and placed in the pesticide decision-making body. However, as will be demonstrated later in this chapter, there are ways of increasing direct participation in policy decision-making that avoid the problems inherent in this extreme. Again, Dryzek and Torgerson (1993) pointed to the Webberian argument that public policy issues are too complex for 'ordinary people', but noted that "experience now suggests that the cost in terms of democracy has rarely been worth the gain in policy rationality" (p.131).

Lastly, it is worth noting that there has been a tendency in recent years to rethink the nature of participation, with a movement away from the involvement of 'every' citizen because of the practical problems inherent in this ideal, and towards "more pluralism within a framework of consensus", according to Jill Bystydzienski and Joti Sekhon (1999, p.8).[21]

7.3.3 'Open-to-all' approaches to public involvement

Although this is the approach to citizen involvement that allows for the greatest possible numbers of participants, it receives little attention in the policy and democracy literature. It invites the involvement of all citizens who wish to be involved and hence it is the methodology that appears to most closely approximate the deliberative democracy ideal. However, in practice, it does not appear to live up to its theoretical promise, as can be seen from experiences with this approach in New Zealand and in the Netherlands. At one end of the scale of involvement is the process of submissions to policy development and implementation that characterises the New Zealand approach to deliberative democracy, and at the other end is the example of the Dutch Study Groups.

Submissions

[21] Bystydzienski, Director of Women's Studies and Professor of Sociology at Iowa State University; Sekhon, Associate Professor of Sociology at Greensboro College, USA.

Over the last ten years, New Zealand has experienced the development of a type of community participation that has been described, by Benjamin Richardson (1999), as being effectively "neutralized" by making it subservient to "private property rights and economic growth imperatives" (p.211).[22] This has occurred primarily through provisions in the RMA, and more recently also through the HSNO Act, and has become established as a wider policy culture in all government departments. The participation takes the form of submissions and objections to proposed plans and policies and resource consent applications. It also takes the form of participation in public inquiries and greater access to the courts to challenge decisions. It is the author's experience that considerable amounts of community time and monetary resources have been tied up in submissions and hearings with questionable real effect on the outcome. This can perhaps be best illustrated by the response to the author's question to Bill Falconer, Chairman of ERMA, at the Authority's public conference in 1999:

Question by Watts:

> To what extent have the submissions influenced the decision-making process? In particular have there been any decisions made, the outcome of which would have been different if not for the submissions?

Answer by Falconer:

> Submissions have influenced the setting of conditions on containment experiments, but it is not clear that they have in anyway altered the outcome of a decision; apparently not, that is without the submissions the decision would have been the same, but with fewer conditions on the approval.[23]

Not one single application to register a genetically modified organism had been turned down by ERMA, although all have been challenged by the community through submissions. Not surprisingly, there appears to be a degree of disenchantment within the community over the effectiveness of participation by way of submission, especially at national policy level. Not surprisingly also, some members of the community have refused to remain submissive and have continued to protest by methods that range from digging up trial crops to taking legal action. When ERMA approved an application[24] to insert human genes in dairy cows contrary to the expressed views of a number of public

[22] Richardson, Senior Lecturer in Environmental Law, University of Auckland.
[23] Falconer's comments were supported by ERMA's 1999 Annual Report (ERMA 1999b, p.3).
[24] Environmental Risk Management Authority Decision. 21 July 2000. Application Code: GMF98009. To field test, in Waikato, genetically modified cattle with extra bovine genes, the insertion of the human myelin basic protein gene, and the deletion of the bovine a-lactoglobulin gene.

interest groups, individuals, and Ngati Wairere, the Maori hapu that has mana whenua[25] over the land on which the field trial was to take place, a number of the submitters moved to challenge the decision in the High Court. This challenge was supported by other members of the public who believed that their opinions were not being given adequate attention by ERMA.[26]

Stephanie Short (1998, p.133)[27] drew attention to the need to differentiate between democratic participation in policy processes and the government's need to consult.[28] The two are not the same thing, although one is often passed off as the other. David Scott (1992) also warned of the problem of consultation being "used to gain acceptance for a proposal that has already been decided upon" (p.434).[29] This approach to consultation was specifically rejected by the Courts in a case under the RMA, *Wellington International Airport Ltd v Air New Zealand* 1991 NZLR 671. It is contended that the participation-through-submission approach falls well short of extended democracy, serving as it often does mainly to fulfil the needs of government rather than those of the community. It is an attenuated form of participation that offers only provision of advice and no direct power (Scott 1992, p.431). Despite the promise by ERMA (1999c) that the submission process "allows for a significant level of public involvement in a formal decision-making process" (p.4), in fact the involvement of the public in the actual decision-making is nil. Additionally, the public's submissions are not even viewed by the decision-making body: instead that body receives a summary of the submissions, carefully prepared by ERMA's staff (ERMA 1999c, p.11). Richardson summed up the situation well when he argued that this approach "can be understood as a strategy to minimize the risk to capital from social protest or excessive environmental damage" (1999, p.211). The semblance of 'taking account of community interest', whilst still denying those interests any direct involvement in decision-making, has served this purpose well. Thus, it is contended that the continued "channelling of environmental concerns into formalized, administrative structures wherein they can be contained and neutralized", that carefully "regulates and blunts their expression" (Richardson 1999, p.211), is not acceptable within an ethical pesticide policy. In such a policy, community concerns must be given standing within the decision-making process itself, not simply accommodated as an easily ignored

[25] Hapu means sub-tribe; mana whenua means authority over the land (Williams 1975).
[26] Personal communication from Dr Peter Wills, University of Auckland (Oct 2000) and Claire Bleakley (Dec 2000), both individuals part of the High Court challenge.
[27] Short, senior lecturer in the School of Health Services Management, University of New South Wales.
[28] For example, the standards of consultation published by ERMA began with the aim of undertaking consultation "in accordance with the HSNO Act" (ERMA 1999c, p.4).
[29] Scott, Land Conservation Council, Melbourne, Australia.

expression of opinion. This is not to suggest that submission processes should be rejected. They should not for, if embarked upon with integrity, they can be an important aspect of the "continuing conversation that is nurtured by a flourishing civil society" (Hucker 1998, p.19). But, it is contended, they are an insufficient expression of public participation in an ethical pesticide policy, and their potential as an expression of democracy is not realized without community support at the decision-making table.

Dutch study groups

Without doubt, the largest exercise in deliberative democracy ever undertaken was that by the Dutch National Government in 1981-83. The scale of the consultation project was, in the words of Jeryl Mumpower, "truly extraordinary" (1995, p.322), costing over US $15 million in early 1980's currency.[30] The subject matter was the national energy policy. The exercise arose out of public dissatisfaction with the government's proposal to build three additional nuclear power plants. Siting procedures had stagnated. The energy policy became deadlocked, with deep conflict rooted in differences that reflected basic disagreement about the need for economic growth, the role of large-scale technologies in society, and issues of scale (Midden 1995, p.307). The government agreed to a proposal, by an "independent group of energy experts and scientists from a variety of social and public organizations" (p.307), for a national debate on energy policy. The debate was aimed at creating a "socially responsible and widely accepted decision" (p.307), with public participation as broad as could be achieved. Equal treatment was given to "reactions of a more emotional or rational nature", to "calculated" and to "perceived" risks (p.308). Funds were made available to develop information and viewpoints in the interest of a fair and competent debate. The money was used for information programmes, magazines, exhibitions, and the training of moderators.

The process involved the following steps (Midden 1995, p.308-9):

* Formation of a steering committee of people proficient in all areas of the issue, with a staff of thirty people, and the legal status of a foundation so as to be independent of the government. It was designed to balance pro- and anti-nuclear interests rather than to be neutral (p.309).
* Full-page advertisements invited groups and individuals to send in information: 36,400 responses were received.
* Then followed public hearings. The results were analysed and used for an interim report. This enabled the steering committee to focus the debate on four key areas

[30] Mumpower, Department of Public Administration and Policy, Nelson A. Rockefeller College of Public Administration and Policy, State University of New York at Albany.

of concern: cost of electricity from nuclear technology, structure of the energy sector, use of risk analysis and risk perception in decision-making, and options for and risks of nuclear waste disposal.

* The next step was "controversy sessions" in which these four areas were debated by experts at public meetings. The objective was to clarify the differences "through confrontation" and to reduce the "segregation" between opposing camps (p.310).
* An interim report of 170 pages was made available for further discussion. A questionnaire was then distributed to elicit comments on the report. Local discussion groups were formed and public meetings took place—in all there were 1,120 meetings with 46,000 people participating in discussions (p.313).
* The final report of 400 pages included the following central policy recommendations: greater energy conservation, use of renewable energy, *no new nuclear power plants*, and decentralised power generation.

It was a massive exercise, with every citizen having an opportunity for input. However, the outcome was advisory only, with the decision-making being left to politicians. The fact that the outcome was not legally binding from the outset damaged the legitimacy of the debate according to Cees Midden (1995), with surveys revealing that "50% of the population seriously doubted the political impact of the whole debate" (p.314).[31] The end result confirmed that the public sceptics were justified in their view: although Parliament itself approved the process, it rejected its outcome and accepted a plan to build three large nuclear power stations (Midden 1995, p.317). The government was legally required to then undertake formal participation procedures in selecting sites, but "all hearings ended in big turmoil and chaos and failed completely" (Midden 1995, p.317). In the end, the massively expense Dutch attempt at deliberative democracy came up against the same challenge to democracy as has the New Zealand submission process: that of citizens expressed views being discarded because the process was non-binding, with a consequent loss of trust in the process and the institutions behind it.

7.3.4 Random citizen selection models of engagement

The second approach to citizen engagement in deliberative democracy involves the random selection of citizens to take part in discourse regarding particular policy issues. This approach usually excludes public interest groups and often also self-selection by individual citizens. The outcomes are non-binding. The two most common models are those of citizen panels and consensus conferences.

[31] Professor Midden, Eindhoven University of Technology, the Netherlands.

Citizen panels

The literature contains a number of descriptions of experiences with citizen panels, known as Planning Cells in Europe and Citizen Juries in the USA (e.g. Shrader-Freycette 1991, p.209; Renn, Webler, Rakel, Dienel & Johnson 1993; Armour 1995; Crosby 1995; Dienel & Renn 1995; Lynn & Karetz 1995; Seiler 1995; Charnley 2000). There are some differences, but the basic methodology of both is the random selection of citizens to provide a 'jury' to study specific public policy issues. The citizens are required to set aside a certain number of days during which they are provided with educative material from technical experts on the subject at hand, and then required to provide an opinion on it, usually in the form of a written report.[32] The technique is used to "elicit preferences and educated responses from citizens" (Dienel & Renn 1995, p.132). The panel is intended to represent a microcosm of the community concerned (Crosby 1995, p.157), and to operate for a short, defined period of time. Volunteers are not used, in order to "avoid groups which are formed of those who felt empowered enough to donate their time" (Crosby 1995, p.170), a comment apparently directed at the exclusion of interest groups.

Many of the issues examined by the citizen panels have been those of local one-off planning issues such as the siting of hazardous waste facilities, nuclear power plants, or coal-burning power plants, in which community negotiation involved elements of financial compensation, together with a review of safety procedures, the formulation of guidelines, and/or impact assessments (e.g. Shrader-Frechette 1991; Kunreuther & Slovic 1996;[33] Tickner 1999, p.176). Ned Crosby stated that by 1995 fourteen citizen juries had been conducted in the USA.[34] Only one of these was on an environmental issue: the impacts of agriculture on water quality. They have not been used for policy formulation. Thus, while they may serve some purpose for local issues of the NIMBY type (Not in My Back Yard), these methods are largely not appropriate for the formation and implementation of national policy, although the Planning Cell approach was used in Germany to determine which of four energy policy options found greatest favour with the citizens (Dienel & Renn 1995, p.131).

[32] This process does not appear to involve lay experts.
[33] They cited English 1992 and Helman 1990.
[34] Crosby, founder of the Jefferson Center, USA.

Consensus conferences

Consensus conferences are somewhat similar to the citizen panels in that they involve a randomly selected group of lay people being given background information on a specific issue, participating in a hearing with experts, then deliberating on the problem, and issuing a report and recommendations. Such lay panels were pioneered by the Danish Board of Technology in the late 1980s and at least twenty have been held in that country since then (Sclove & Scammell 1999, p.257), leading them to be referred to as Danish Consensus Conferences (TT—WTWT 1996, p.16-7).

However they differ from citizen panels in the type of issues they deal with. Tickner (1999) asserted that consensus conferences work best for "big issues" (p.176). According to Sclove and Scammell (1999), they are intended "to stimulate broad and intelligent debate on policy issues involving technical complexity and scientific uncertainty" (p.257). Certainly, they seem to have found favour in the area of genetic engineering with conferences on the subject held in the UK, Netherlands, Denmark, and New Zealand (TT—WTWT 1996, p.2). Their intended purpose is that of informing policy-makers about public attitudes on a particular subject, rather than to develop public policy (Sclove & Scammell 1999, p.257). Hence, they were seen by Sclove and Scammell (1999) as "a democratic process that helps ensure informed consent" and to steer the development agenda down "specially preferred paths" (p.258). They are not democratic in the sense of involving the public in actual decision-making, which it is contended is necessary for ethical pesticide policy. Whilst these conferences function best when the public is faced with specific issues, such as the introduction of genetic engineering or irradiation of food, they are not so well suited to ongoing policy matters relating to a technology that has pervaded people's lives to the extent that pesticides have, nor to the development of a comprehensive national strategy (Sclove & Scammell 1999, p.258). Having said that, it is feasible that consensus conferences might have a role to play in specific pesticide issues such as the proposal, by public interest groups in New Zealand, to make spray drift an act of trespass and hence illegal. Such a proposal has broad social ramifications involving private property rights and public duty.

Problems with the random citizen selection and non-binding approaches

A number of authors have determined that the citizen panel approach to public participation has been successful and promote these methods of deliberative democracy, at least for local planning issues (e.g. Fischer 1993; Renn *et al.* 1993; Crosby 1995; Dienel & Renn 1995). Kunreuther and Slovic, in discussing a community participation approach in

which local residents were given the authority to negotiate the terms for siting a hazardous waste facility, noted that as a result of the participation many facilities were not sited at all (1996, p.124). In the 1980s only six out of eighty-one applications for hazardous waste facilities were built.[35] The authors also noted that there was evidence suggesting that the process "enhanced the success of a number of siting efforts" (Kunreuther & Slovic 1996, p.124).[36] Charnley referred to "mixed results" (2000, p.16) of the implementation of these co-operative discourse models in Germany to address energy polices and waste disposal issues, and in the US to develop sludge-disposal strategies. She did not elaborate on why, or in what way, the results were mixed.

There have also been many problems identified with exercises in deliberative democracy. Steelman and Ascher referred to a general lack of success with many such exercises for reasons that include tenuous commitment from bureaucrats, unclear direction from elected representatives, perceived apathy of the public, lack of public competence, poor planning and program design, lack of bureaucratic experience with public involvement, and the political mandate for public involvement not being sincere in its intent (1997, p.72-4).

Random citizen engagement models have two common problems with respect to ethical pesticide policy as proposed in this thesis. Both of these problems are interlinked with the deliberate exclusion of public interest groups from the process. Firstly, all the models, with the exception of the Dutch Study Groups, leave technical expertise intact in its dominant epistemological position, perpetuating the dualistic approach of experts and citizens, the one providing the knowledge and the other the social values. This problem arises also with the open-to-all model of submissions as demonstrated by ERMA's undertaking to "show respect for submitters and their genuinely held views and beliefs" (ERMA 1999c, p.6): no mention of submitters' knowledge and expertise. The models all fail to recognize lay knowledge and experience as expertise, assigning only the 'lesser' role of social values to citizen input—lesser in the sense only that social values are regarded as secondary to scientific 'truths' in the current climate of scientism that dominates public policy. The citizens are given carefully selected material on which to base their opinions: Crosby (1995) identified one problem, at least with the American citizen juries, as that of bias on the part of Citizen Jury staff, noting that "it is rare for staff not to impose its own values on the organization it runs" (p.163). As this thesis has argued that community experience and lay expertise, especially that which resides in

[35] They cited Helman 1990.
[36] They cited Varis, Mumpower & Reagan-Cirincione 1993.

grassroots public interest groups, is an essential ingredient in a wise pesticide policy, this approach is not considered an acceptable means of arriving at ethical pesticide policy. Even if the citizens were given access to lay expertise, it is contended that a three to five day process[37] would be insufficient time for a group of inexperienced citizens to come to grips with the problems of toxicology, endocrine disruption, multiple chemical sensitivity and the ramifications of ongoing low dose exposure to mixtures of chemicals for both humans and the wider ecosystem, especially since such an understanding would appear to require the unlearning of conditioned concepts like 'the higher the dose the worst the effect'.

Secondly, these models leave bureaucrats in the position of sole decision-makers, effectively preventing any real influence by the affected public on pesticide policy. Because the outcomes of these processes are advisory only they are vulnerable to the same fate as the material presented in submissions and to hearings, that is polite attention and then policy dismissal. No matter how democratic and encompassing the model is, if the advice is simply dismissed by the decision-makers, then little has been achieved by the expenditure of time and money. Indeed, it is argued that the result is likely to be disenchantment with the process, the decision-makers and the government, with a concomitant erosion of trust in these institutions. Hans-Jörg Seiler (1995) argued that the use of citizen panels is "most problematic when applied to very controversial matters or matters in which strong equity concerns exist" (p.151) and are of reduced value as consultative bodies for Parliament.[38] This is because the panels can only come up with recommendations which are unlikely to change the views of those involved in political discussion who already have a formulated opinion. Seiler's point is well illustrated by the Dutch Study Group experience described earlier.

Seiler's point is also illustrated by the experience with consensus conferences. In Norway, a consensus conference lead to the government banning genetically modified crops because of the potential risks involved and the lack of need for additional food, according to Tickner (1999, p.176).[39] In New Zealand, however, a similar consensus conference on genetic engineering came to quite different conclusions. It concluded that "plant biotechnology is a reality", that "it is too late to 'return the genie to the bottle', and that the HSNO legislation, when operational will provide adequate safeguards, if

[37] Three to five days is the usual length of time allowed for the citizen panels (Crosby 1995, p.158; Dienel & Renn 1995, p.122).
[38] Seiler, director of the interdisciplinary research project on Risk and Safety of Technological Systems, Swiss Federal Institute of Technology, Zurich.
[39] Tickner cited Sclove 1997.

enforced" (TT—WTWT 1996, p.2). Despite that finding by the randomly selected citizens, ongoing protests by public interest groups and political parties, and high level persuasive PR by the biotechnology interest groups, have led the New Zealand government to constitute a Royal Commission into Genetic Modification. The Commission is to decide amongst other things whether or not genetic modification will be a reality for New Zealand. The HSNO legislation, under which genetic modified organisms are regulated, is now operational, but whether or not the safeguards it provides are adequate can only be determined with time and after the event. As it stands, an appeal against ERMA's decision to allow the insertion of human genes into cattle is being taken by members of the public unhappy with the Authority's processes, as previously mentioned. Thus, two consensus conferences on the same subject came to broadly opposite conclusions, with one failing to resolve intense social conflict over the issue involved.

In conclusion, none of the examples of citizen engagement reviewed so far are suitable for ethical policy formulation at a national level, which is the matter of interest here. It is contended therefore that, whilst broad public discourse is to be welcomed and is a necessary feature of ethical pesticide policy, it is not in itself a sufficient expression of extended democracy. One problem lies with the continued adherence to the notion that the public represents values and the scientists represent knowledge and facts. There is a failure to address the issues of values in science and knowledge in the community, and to replace scientism with wisdom as the guiding force in public policy. Concomitantly, the deliberate exclusion of public interest groups, which can be repositories of valuable expertise, further undermines their usefulness. Whilst the deliberative democracy approach attempts to theoretically provide access to any citizen through random selection, they do not in fact achieve access for every one but only for the limited few selected. The exclusion of public interest groups means that those selected will be members of the public largely lacking in expertise, and hence perhaps open to being persuaded by the dominant scientific paradigm that is laid in front of them. Additionally, they are accountable to no one. Because the outcomes of these exercises, like the submission exercise, are advisory and non-binding, they fail to contribute sufficiently to improved democracy in the decision-making process, leaving intact the power of Webler and Dienel's 'elites'. Nor do they resolve the social inequity created by industry's privileged relationship with Government.

Robin Cantor (1996, p.142) noted these deliberative engagement models have emphasised the role of democracy in determining risk priorities at the local community

level. However, it is contended that this enhanced democracy has not been translated to the wider policy questions and the more encompassing national policy agenda-setting and decision-making processes. Nor, it is contended, has it necessarily captured the issues of equity and environmental ethics that Cantor (1996, p.141) rightly points to as characterising current debates about risk. The models do not fulfil Shrader-Frechette's requirement of informed consent to the resultant risk, for the randomly selected citizens are responsible for and answerable to no one. At least public interest groups do have a mandate to represent their members if no one else.

7.3.5 Interest group models

There is a clear trend in some countries towards an interest group pluralism model of involvement of both public interest groups and industry groups in policy matters, especially those relating to pesticides. In this model, the values of conflicting stakeholder groups are elicited and explored, 'expert' assessment of 'facts' is provided, and alternatives are explored (von Winterfeldt 1992). This approach, commonly referred to as the multi-stakeholder approach, appears to have had its origins in citizen advisory committees, which although confined to local issues, are briefly canvassed here for completeness.

Citizen advisory committees

A number of citizen advisory committees were formed during the 1980s in the United States, Canada and Western Europe, mainly to provide advice to various levels of government. With regard to central government policy-making, they usually provided general guidance on implementing environmental law, promulgating regulations, issuing permits and siting planning facilities such as for hazardous waste destruction. They do not appear to have been used for developing national policy. Generally with this model, the issue is defined and shaped by the government agency concerned, so only that which the agency wants discussed can be discussed. This automatically limits the policy agenda in favour of traditional interests, power groups, and scientific expertise.

The selection of members for the group—typically representatives from interested citizens organisations, trade and industry groups, and the general public—is also carried out by the government agency (Vari 1995, p.103-5). The outcomes of the Committee's deliberations are advisory only. Anna Vari (1995, p.113) advised that these types of

groups can be most effectively used for local problems, or problems where only a few, well-defined groups are affected.[40]

The multi-stakeholder model

Gail Charnley (2000, p.4) described the interest group pluralism model of administrative action that is taking shape in the USA, in which regulatory agencies act as brokers for the interested parties. Risk management decisions are developed and implemented through collaborative processes involving consultation and cooperation among stakeholders, including regulators, regulated parties, advocacy-based organizations, and the general public. One of the many ways in which this approach is implemented is through 'regulatory negotiation', an approach adopted by US government agencies in the 1980s. In this approach, the government agency involved brings together the potentially affected parties in order to define general rules, such as the Farmworker Protection Standards for Pesticides (Fiorino 1995, p.228). The affected parties are, practically, anyone who may be expected to challenge the rule later in the federal courts (Fiorino 1995, p.225). This model thus includes a variety of stakeholders in virtual decision-making, under a process that offers them, according to Fiorino, a rough parity with government decision-makers (p.224), although actual rule-making still is the prerogative of the bureaucracy, working from the basis of the consensus achieved in the negotiation process. This process has become an important arena in the competition for influence over public policy, according to Fiorino (1995), and it is a reflection of the adversarial nature of US political structures (Hadden 1995, p.239).

This multi-stakeholder advisory approach has been implemented in the arena of national pesticide policy in a number of countries, largely in an advisory capacity only. In Sweden this approach was used to develop and implement the voluntary reduced use programmes that commenced in 1986 (Bernson & Ekstrom 1992; Hurst 1992). In the UK an advisory multi-party Pesticides Forum was established in 1996 to facilitate the minimization of pesticide use (Shannon 1997). In the Netherlands a multi-stakeholder negotiation process was used to design and implement a pesticide reduction programme initiated in 1992 (Proost & Matteson 1997). All of these examples involve the stakeholder groups in an advisory capacity, with decision-making, including that relating to registration, remaining with the bureaucracies. However, in New Zealand, the multi-stakeholder model is operative in both the binding decision-making and non-binding advisory modalities with regard to pesticides. The Pesticides Board, as described earlier in this chapter, is a statutory authority set up under the Pesticides Act 1979, consisting

[40] Professor Vari, Budapest, Hungary.

largely of interest groups together with government bureaucrats, and making binding policy decisions. On the other hand the Agricultural Chemicals and Veterinary Medicines Advisory Group (AVMAC) is a non-statutory advisory group set up by the Ministry of Agriculture to act as "a conduit for advice, sharing information and gathering opinion" (MAF 2000b, p.6). It does not make decisions.

Although the multi-stakeholder approach has an appearance of fairness, with the input of societal values and 'presence' of affected parties, whether these promises are achieved in practice is another matter. It requires accurate identification of the stakeholders, accurate, open and unbiased identification and presentation of alternatives, and accurate and unbiased analysis of 'facts'. Perhaps the biggest problem is that of achieving a balance between the various stakeholders, especially in terms of power, which itself depends on financial backing:

> Pluralist discourse assumes that conflicting interests are the essence of politics and, in a democracy, cannot be resolved by appeal to an overriding public interest discoverable by experts. Instead, the public interest is served by creating an open political process that allows contending organized interests equal opportunity to influence public policy. Adopting the logic of market relations and its political analog in the group competition of pluralist politics, this perspective assumes equality of opportunity, political equality, and freedom.
>
> Williams & Matheny 1995, p.20.

Public interest groups are usually at a significant disadvantage when faced with industrial lobby groups, for this adversarial pluralistic model pits one side against the other, each striving to maximize its advantage (Fiorino 1995, p.227). This situation is usually characterised as environmentalists versus industry, and has been well illustrated with respect to pesticides in the USA (Bosso 1988; Nownes 1991). There, the intense rivalry resulted in the marginalization of farmers' interests. This basic conflict in interest between environmental groups and pesticide manufactures leaves little room for agreement, so an adversarial process inevitably results in the more powerful side dominating, and it is contended that this is inevitably industry.

In practice, in New Zealand at least, a balance of interest has not even been sought in the pesticide policy bodies mentioned above. When there is only one representative of community, environmental, consumer and organic farming interests, faced with nine people who represent either users, sellers or manufacturers of pesticides and a number of bureaucrats with expertise in positivist science, as is the case with the Pesticides

Board, then that representation can be seen as little more than tokenism.[41] The situation is even worse with AVMAC. Again there is one official representative of consumer concerns, none at all for environmental or other public interest, or for organic farmers, but there are nine representatives of the chemical industry and of user groups (MAF 2000b, p.10-13).

A further problem with the model as it has been implemented to date, arising in part from this domination, is that it has continued to place emphasis on science as the sole epistemological basis of knowledge, disenfranchising other forms of wisdom. It leaves the traditional experts in charge of expertise, and fails to accommodate lay expertise and community experience in a meaningful way. They remain subordinated, as social views, rather than being accorded the status of wisdom, knowledge and expertise that was bestowed upon them in Chapter 6.

Michael Jacobs warned that the use of interest group consultative forums is a "disguise for government's inaction" (1999, p.34) by effectively passing the responsibility for policy implementation on to everyone else, especially business, individuals and voluntary organizations. This criticism could certainty be levelled at MAF's Spray Drift Advisory Group, which has enabled MAF to appear to be addressing the problem when, it is contended, nothing concrete has actually been achieved at all in three years of halting operation.

Jacobs (1999, p.34) also warned that this interest group consultative approach limits participation to only the major stakeholders in society, excluding ordinary members of the public. In a similar vein, Greg Hampton (1999, p.170) expressed a concern about citizen committees that is also applicable to the multi-stakeholder approach: the potential for the participants selected by the government agency to be those who will assist the bureaucracy to pursue its own agenda, a form of co-option of the interest groups concerned.[42] Such a situation may have occurred in New Zealand, in 1999, with the selection by MAF of the Consumers Institute to represent consumers' views on the Antibiotic Resistance Steering Committee. Other consumer organizations that had expressed a clear opposition to antibiotic use in animal feed, contrary to MAF's own position, such as the Safe Food Campaign, were not invited onto the committee. Pieter Leroy and Jan van Tatenhove (2000, p.202) made a similar comment about some of the

[41] The author is the representative, theoretically, for the environmental interests, but practically also advances the interests of consumers, the community, and organic farming, as these are linked and they would otherwise not be addressed.

[42] Hampton, Technology and Environmental Strategies Research Group, University of Wollongong, NSW, Australia.

consultative bodies that have been created in the Netherlands since the 1980s.[43] They characterised some of these as neo-corporatist because only pressure groups acknowledged by the state can get entrance to these bodies. Williams and Matheny (1995, p.33) also referred to the routine participation of mainstream environmental and consumer groups within the USA regulatory process, to the exclusion of newer or smaller groups:

> They became vulnerable to the claims of grassroots groups using the communitarian language that they were part of unrepresentative and illegitimate political and economic institutions unresponsive to the interests of the people.
>
> Williams & Matheny 1995, p.33.

Val Plumwood strongly criticised the liberal interest group model that underlies the multi-stakeholder approach, as one that "takes egoism, inequality and dominance for granted, provides poorly for collective goods, and allows systematic redistribution of ecological ills to weaker groups" (1998, p.570). The system allows for "an unquantifiable, highly diffuse, generalisable, and perhaps not easily detectable ecological harm [to be] pitted against a quantifiable economic benefit accruing to a small (often very small) but highly concentrated and influential group" (p.570). In part this occurs because the interest group model of liberal democracy produces "radical economic inequality, often in association with racial, gender, and other kinds of marginality and cultural subordination" (p.570). Plumwood's critique is concurred with: this is precisely what has occurred in multi-stakeholder models in the pesticide arena, and thus the use of pesticides escalates as does the damage that is caused to the environment and many of those that live within it.

Despite these criticisms, the approach proposed in this thesis has some similarities with the multi-stakeholder approach although the pluralist model is rejected, not least because it assumes conflict of interests, and the problems pointed to here will be addressed and resolved later in this chapter.[44] Plumwood (1998) argued that for the interest group model to function in a manner consistent with ecological rationality, it

[43] Leroy, Professor of Political Sciences of the Environment, and van Tatenhove, lecturer in Political Sciences of the Environment at Nijmegen University, the Netherlands.

[44] Williams & Matheny also asserted that pluralism suffers from an "underlying assumption that the flaws in objectivist models of scientific knowledge lead inevitably to relativistic models of politically relevant truth" (1995, p.46). Thus they inferred that pluralism means cultural relativism and policy-making that excludes scientific information. To the extent that their assertion about pluralism is true, then pluralism is also rejected on this ground, for this thesis has argued that scientific knowledge and community knowledge derived from experience and learning must take their places alongside values in the policy process.

must "include advocates for and ways of representing more-than-human nature and also for the 'public interest' or collective good" (p.575). The model proposed in this chapter fulfils, it is contended, Plumwood's requirements, at the same time meeting her 'lessening of remoteness' qualification, as will be discussed later.

Opposition to public interest group participation

However, first a comment about opposition to the involvement of public interest groups is required. The majority of the models reviewed in this chapter intentionally exclude such groups. Some of the commentaries on the models contain explicit adverse comments on public interest groups, but without supporting evidence to back the assertions. For example, Shrader-Frechette, in promoting the concept of obtaining informed consent to risk, posited a negotiation process for decision-making controlled by a group of citizens and experts in place of a government agency. She believed this would reduce the likelihood of it being "co-opted by unrealistic environmentalists or unscrupulous industry representatives" (1991, p.207), but provided no evidence to back the assertions that environmentalists are unrealistic or industry unscrupulous.

Dienel and Renn (1995) were much more dogmatic in their specific exclusion of representatives of public interest groups. They inferred that these contain "professional citizens", "the aggressive type of citizen who claims to speak for the rest of the world", "advocates of common causes [who] deny their own self interests and know better than everybody else which policies are needed for the common good", "the moralist who wants to impose his or her moral standards [on] the rest of the world", and the "hobby politician who wants to be celebrated for all his or her involvement and does not miss a chance of being portrayed in the media" (p.120). The authors did not provide any justification for this judgement, or references to sources of information to verify it, or concrete examples. It is contended, therefore, that this is no more than a personal opinion that demonstrates a certain bias against the involvement of organised public interest groups in policy processes. The authors also stated a belief that interest groups are concerned only with the interests of their own group, rather than the common good of society as a whole, which they claim is the concern of the ordinary citizen (p.126). Again, no justification for this view was provided, but the view itself was used to justify the random selection of citizens to the panel and to exclude representatives of interest groups. The authors also made the comment that citizens "do not depend on special constituencies, such as voters or interest groups" (p.126), inferring that representatives of public interest groups cannot act impartially. Such a view of the relationship between interest groups and citizens stands in stark contrast with that provided by Sylvia Tesh

(1999), who asserted that "citizens express their perception of risk largely through organized citizen groups and these groups employ and have access to many experts" (p.39).[45] As Tesh pointed out, in order to influence the agenda setting and policy-making processes, citizens have to organize into groups to have much influence (p.43). The individual citizen has very limited power in this regard, particularly compared with the industrial lobby whose influence on policy-making has already been addressed in the section on democracy. The question then is one of how ethical is it for the policy process to deliberately by-pass the groups that citizens have joined in order to express their opinions and to try to achieve some degree of influence on policy.

Concluding comments

In conclusion, it is worth noting the striking regularity with which authors have acknowledged that the significant differences in assessment of risks, which exist between (and within) technical experts and the public, are a result of differences in values, and that there is no reason to believe that scientists' values are superior to citizens values. Yet, with equally striking regularity, they fail to take the process one logical step further and provide for the *adequate,* which it is contended means the *equal*, incorporation of those differences of values into policy decisions. It is contended that the reason for this is simply an unwillingness to give up, or to share, the power inherent in being a decision-maker. Collecting up the public's views about an issue does not in itself ensure their accommodation within public policy. All it does is provide for an expression of those views without providing a means for their incorporation. It is contended that the ethical development of pesticide policy requires inclusion of societal values and community knowledge and expertise, and the direct participation of the public in order to ensure this occurs. It is worth noting that, although Tickner (1999) stated that structures must exist for the public to participate both in the collection of information on which to base decisions "and in the decisions (scientific, technological, and political) themselves" (p.175), the suggestions for approaches that he then put forward did not in fact involve the public in actual positions of decision-making power. This is a common feature of many of the writings on democratization of science and policy in which, it is contended, the practical suggestions fall short of the philosophical assertions. There appears to be a reluctance to provide a direct challenge to the status quo power distribution in policy processes.

[45] Tesh, School of Public Health, University of Michigan.

Nicholas Rescher's words in his Distinguished Lecture on Public Affairs, delivered at the State University of New York, warn of the difficulties faced in gaining acceptance of the proposal put forward in this thesis:

> Ever since the infancy of political theory in the era of Plato's *Republic*, political philosophers and theoreticians have manifested a deep aversion to genuine democracy. Dismissing the generality of people as "the masses" (*hoi polloi*—the great unwashed), they have insisted on the need to have matters decided by wiser heads (invariably, it seems, those belonging to people very much like themselves). No matter how loudly they enthuse about "the people", "the citizenry", and "the common man", political gurus have insisted, almost without exception, that in matters of actual decision it is necessary to have others act on their behalf.
>
> Rescher 1999, p.304-5.

There is one last feature of extended democracy that needs to be briefly addressed, one that Dryzek (2000, p.81-2) drew attention to: the degree to which it should be sought, and the relationship between the public sphere and civil society will vary with place, time, type of state and also policy issue. The intention here is not to develop a general theory of democracy relevant to public policy, but rather to address the needs of one small island nation with respect to pesticide policy. Many of the general principles can be applied across the world and across policy issues, but the particular development proposed is directed at pesticide policy in New Zealand at the commencement of the new millennium. It is context dependent.

7.4 Ethical pesticide policy decision-makers

The previous sections in this chapter have provided a wide-ranging review of opinions about and experiences with various approaches to decision-making and who should be the decision-makers. The case was made for greater democracy in pesticide policy. The case has also been made previously for that policy to incorporate social values, lay expertise and community knowledge, and to be based on ecological rationality and an ecocentric ethic. The proposal presented below will, it is contended, encompass these requirements and enable balanced decisions to be made that address society's needs in relationship to pest, weed, and disease management.

7.4.1 The proposed decision-makers

It is contended that the best means of achieving balanced decisions incorporating social values, positivist science, community knowledge and an ecocentric ethic, whilst at the same time addressing the need for greater democracy in pesticide policy, is through the significant inclusion of lay experts in the process.

The term significant needs elaboration. It is proposed that lay experts from, or working on behalf of, public interest groups that seek to protect human health and the environment should form one third of the membership of bodies involved in both the development and implementation of pesticide policy. A second one third should be representatives of the interests of those who need to control insects, weeds and diseases, hereafter referred to collectively as pests. These will largely be agricultural and horticultural interests, and will encompass those who use pesticides and those who have expertise in methods that minimize damage to the environment. The remaining one third of the decision-making group should be the necessary bureaucrats.

These percentages are relative only, for it is contended that there should be two additional people involved in this tripartite group. The first is an independent chairperson. It is essential that this chair is independent of all 'thirds' and competent in providing impartial direction of the process in a manner that prevents any 'third' dominating. As will be discussed later, there are significant difficulties involved in ensuring equitable discourse amongst parties of differing worldviews within a system that traditionally has promoted technological rationality and in a policy area that has a history of adversarial conflict. The success or failure of the ethical process hinges partly on the ability of the chairperson to enable an equitable process, to facilitate a positive relationship between the 'thirds'. Because the ethical policy process requires admission of lay expertise, community experience and technical expertise, it is important that the chairperson does not come from an epistemological background of technological rationality, as this, it is contended, would bias the process against lay knowledge and social rationality.

The second additional person proposed is one who would have the sole task of ensuring that the ecocentric ethic is understood and applied, so that the resulting policy and implementation of that policy do in fact successfully operationalize that ethic—a type of ecocentric advocate. Although it will be argued later that the provision of an underpinning ecocentric ethic in some ways implements Anne Philips 'politics of presence' with respect to non-human nature, it is contended that, initially at least, it will

be insufficient. It is anticipated that there may be difficulties in translating the ecocentric approach into ethical pesticide policy against the background of current practice, expectations and attitudes, particularly those of the bureaucrats and pesticide users. Therefore, there is likely to be a transitional period during which special attention will need to be paid to ensuring that, for example, the anthropocentric assumptions of unproven need and presumptive rights do not continue to dominate the process and undermine the principle of minimum harm. It is feasible that with time and the experience of successful implementation changes in attitudes may render this 'advocate' redundant. Therefore, the proposed system is viewed in terms of a tripartite group, augmented by an 'ecocentrist' whose function is to ensure that the partnership between humans and non-human nature, as described in Chapter 5, is pursued with integrity.

The tripartite policy model proposed here has some similarities to the regulatory tripartitism proposed by Ian Ayres and John Braithwaite (1992, p.57-60) and by Michael Hogan (1995), in which "community interests are empowered to be full participants along with regulators and regulated firms" (p.3).[46] In this proposal, however, the third party is largely farmers and growers rather than the manufacturers and sellers of pesticides. Like Ayres and Braithwaite (1992, p.6), and Horgan (1995, p.3), this thesis asserts that the (augmented) tripartite approach is the best way to nurture democracy and serve the public, ecological and farming interests. It will be immediately evident that the pesticide manufacturers and sellers have been deliberately excluded from the policy triumvirate. There are very good reasons for this and they will be discussed in section 7.4.4. For now, the exclusion is merely noted.

Figure 7.1 The pesticide policy model of augmented tripartitism

Bureaucrats

Chair

Public interests

[46] Ayres, Professor of Law at Yale Law School; Braithwaite, Professorial Fellow in the Research School of Social Sciences at Australian National University; Hogan, Director of the Public Interest Advocacy Centre, Sydney.

'Ecocentrist' Pest management interests

It is proposed that scientific experts also do *not* form part of the policy group as members, but rather that their knowledge be contributed to the process, particularly in the form of toxicology and ecotoxicology. There is a bureaucratic tendency towards technological rationality already that will serve, it is contended, the interests of science. Additionally, there is the traditional relationship between the pesticide industry and scientists that suggests the latter's presence in the policy group might violate the principles of procedural fairness and formal equity (Hampton 1999, p.168):

> The power of vested interests in research-related conflicts is especially evident in the case of pesticides. For example, one reason that the largely accurate work of Rachel Carson was so violently attacked was that many of the leading scientists of the day had financial ties to the pesticide industry.
>
> Shrader-Frechette 1994, p.68.

Further, it is proposed that the scientific information admitted to the process no longer be provided by the pesticide manufacturers, as is the norm currently. It is contended that the requirement of corporate entities to make profits from their products, which will be discussed later, conflicts with the provision of unbiased information about the adverse effects of those products. Several examples of the falsifying of information were provided in the previous chapter. It is contended that, instead, the required toxicological information should be provided by scientists independent, to the extent possible, of the pesticide industry but at that the latter's expense. The phrase 'to the extent possible' recognizes the information also provided in the previous chapter, and referred to in the quote above, of the financial relationships between 'independent' scientists and corporate business. This relationship may be lessened through administration of the financial arrangements between the pesticides industry and the scientists by the government, overseen by the policy group. In other words, the policy group determines the scientists that are paid by the government to undertake the toxicological evaluations, that money

being recovered by the government from the pesticide industry. Although this proposed arrangement is contrary to the general government direction of promoting financial links between corporate business and the provision of scientific information, it is contended that such a relationship is unethical in the provision of information about adverse effects of products, and hence cannot be countenanced in ethical pesticide policy.

There is again the issue of gender. Evidence has been provided throughout this thesis of gender differences with respect to pesticides. There are significant differences in the ways in which women are affected by pesticides and in the assessment of risks from pesticides, both by the public and by toxicologists. There are issues of differing values, knowledge and experience. Therefore, it is contended that at least 50 percent of the group's members, including the chair and 'ecocentrist', should be women. Preferably each sector of the policy group, i.e. lay experts, growers/farmers, and bureaucrats would have a gender balance, to prevent a possible disenfranchising of one sector through inadvertently discriminatory modes of communication.

Similarly, there is the issue of Maori representation. As mentioned in Chapter 1, New Zealand is officially a bi-cultural country, and modern legislation is increasingly reflecting that situation. In particular, the RMA and HSNO Acts require consideration of Maori cultural issues. Yet, as been referred to already, Maori cultural issues are not being reflected in the decisions being made by ERMA under the HSNO ACT. It is contended, therefore, that 50 percent of the decision group should be Maori in order to implement the nation's bi-cultural responsibilities. Even though Maori constitute less than 50 percent of the population, equality within a bicultural system, it is contended, demands equality at the decision-making table rather than mere representativeness.

The augmented tripartite model proposed here has not been found elsewhere in the literature, although support for the general direction of this approach can be found in the writings of many, as will be demonstrated throughout the remainder of this chapter. It is likely to be contentious because it challenges the standard distribution of power within the policy arena, redistributing some of that power to public interest groups and omitting the pesticide industry. These issues will be addressed here, together with the perceived adversarial nature of the interest group approach and a perceived conflict between ecological rationality and democracy.

Challenging policy power and implementing participatory democracy

Currently, pesticide policy is characterized by a bureaucratized exercise of power that is highly influenced by the desires of the pesticide industry. This influence is evident in the

adherence to technological rationality expressed via risk assessment, positivist science, and the assignment of the burden of proof to the public. All of these serve as control mechanisms for the maintenance of the status quo (Armour 1997, p.53). What is suggested here is a shift in the seat of power away from the pesticide industry and technological enthusiasts, who are a minority in society that wield influence far in excess of their numbers, and in favour of broader societal interests through "a modernization of democracy" (Armour 1997, p.55). The proposal is not for full, direct participatory democracy, in which any member of the public would be invited to participate in the process as a decision-maker (Bystydzienski & Sekhon 1999, p.7-8). This approach could be described as strongly postmodernist, in that it deconstructs and dismisses any level of expertise. Additionally, as Goodin noted:

> The root idea running through . . . demands for 'participatory democracy' is not, as is often claimed, that everyone should be self-determining completely and in all respects. Rather, it is that more people should have more say over more of what happens to them.
>
> Goodin 1992, p.128.

This is not to suggest that full, direct participatory democracy does not have a significant role to play in many community issues, but rather that in this instance of national policy, with a long history of bias in favour of technological enthusiasm, it would be counterproductive. The proposal instead is for a carefully structured and balanced process that permits social values, community experience, lay expertise, scientific expertise, farming needs and bureaucratic regulations to contribute meaningfully to the decisions surrounding the registration and use of pesticides.

Thus the model proposed, whilst going beyond the modernist paradigm of a singular rationality (Wynne 1992, p.295), at the same time does not embrace the stronger form of postmodernism that "so relativizes values and fragments identities as, in effect, to allow whatever succeeds in imposing itself as a new order to create its own conditions of legitimation" (Wynne 1992, p.296). Rather, it is an approach that fits between the two extremes. It is an approach that provides for a carefully constructed policy process in which lay knowledge and community experience, or post-normal science, are allowed to function alongside positivist science in determining the policy choices that fit with society's needs and values. It incorporates elements of several political models. To a certain extent it fits within the deliberative democracy genre as opposed to adversarial democracy (Dryzek 1996, p.113-4; Connelly & Smith 1999, p.61), in that it incorporates supposedly opposing interests reaching agreement within, and regarding, the policy framework. However, it lies more within the direct participatory democracy framework

for it involves members of the community in binding decision-making, yet retains elements of representational democracy. It rejects the random citizen approach of deliberative democracy and contains elements of the interest group pluralism or multi-stakeholder approach, although in a constrained manner. It does not, however, reject deliberative democracy as such, for it is not intended that the proposed decision-making body operates in isolation from the community. It is intended that broad public discussion and involvement through submissions and hearings continue as an adjunct to the proposed policy body, and that the latter will improve the effectiveness of the former. Public submissions can potentially be of greater influence if the decision-making body contains representatives of public interest groups who can ensure those submissions are paid adequate attention.

In defence of public interest groups

The literature on public participation tends to display a negative attitude towards the involvement of public interest groups in policy. That attitude is expressed in a variety of ways, ranging from ignoring their existence as policy actors, through a show of nervousness relating to dominance (e.g. Hampton 1999, p.170), lack of realism (Shrader-Frechette 1991), charges of vested interest, to open hostility as was reported in section 7.3.5. As was mentioned in that section, none of the authors provided material evidence to back their beliefs, hence they cannot be countered in a meaningful way.[47] Instead, the focus here will be on why public interest groups are by-passed in the democracy debate and on the positive contributions they can, and do, make to policy processes.

The argument of effective participation

The vast majority of the literature on extended democracy has advocated a sharing of power by the bureaucrats and vested interests with the individual and powerless citizen, through the nebulous terminology of 'public participation in decision-making'—on the way effectively by-passing those groups who have traditionally represented public interests and promoted social causes. It is contended that that approach fails to address the fact that the individual citizen, acting alone, has far less chance of altering the status quo and achieving what it is she or he seeks, than groups of citizens acting together in mutual interest. To the extent that governments practice this approach to participation, it is difficult to view their actions in any way other than as a charade—a charade of public

[47] The vested interest argument has no merit with respect to public interest groups, for the thing they are said to have an interest vested in is the same thing that government is supposed to have an interest vested in, namely public good.

involvement that disguises a reluctance to give up any actual power displaying, at the least, what Steelman and Ascher referred to politely as lacking 'sincerity' (1997, p.74). Shrader-Frechette (1985) argued that if decisions regarding a technological issue will affect the people, then the democratic ideal is that decisions relating to that technology ought to be made by those people or their peers, and not by "alleged experts" (p.298). In her view, the most appropriate people to be involved in the decision-making are "intelligent lay people", although she does not specify who exactly these might be, other than by a passing reference to lawmakers (p.295). It is contended, however, that these intelligent lay people can be found within public interest groups on the one hand, and farming organizations on the other.

The argument of leading social innovation

According to Bosselmann (1995), French social theorist Alain Touraine warned, more than twenty years ago, of the process by which the 'incumbent elite' play down new ideas and values, and yet at the same time take them over and take advantage of them, a process that has been "one of the basic experiences throughout history" (p.279).[48] There are two points here. The first is that the issues raised by environmental groups, public interest organisations, and dissident scientists, initially scorned, are eventually accepted as valid, the wording adopted but the meaning watered down. Such a process has occurred with the term 'sustainable'. The term reached prominence through the activities of environmental organisations and ecocentric minded individuals, till eventually it became part of international charters and national laws. However, in the process, the definition gradually shied away from the ecocentric ethic and slide comfortably once more back into anthropocentrism, where sustainability of the environment is seen as hinging firstly on the continued fulfilment of human needs. Dobson (1998), noting that there are now more than 300 definitions of 'sustainable' (p.33), made the point that the contested nature of its meanings "gives governments the possibility of playing a legitimizing game" (p.242). The process allows for a barely perceptible shift in values cloaked in a veneer of green which permits people to feel good about the new environmental awareness and promised improvements, whilst anthropocentric business continues as usual. The second point here is that it is the environmental groups, public interest organisations and dissident scientists who do in fact bring those values to the fore in the first place, the values which are eventually, and inevitably adopted by society, to the extent that is that the technological elite permit. And it is these people who are required in decision-making positions, not only to ensure those values are adequately

[48] Bosselmann cited Touraine 1976.

implemented, but also because of their ability to foreshadow later developments and understanding.

The pesticides and farming arenas are well endowed with examples of visionary thinking and advocacy of ideas and knowledge that later are adopted as mainstream thinking and supported by regulatory action. There are individuals such as Lady Eve Balfour who, in the 1940s, developed the modern philosophy of organic farming, and Rachel Carson who alerted the world to the problem of persistent organochlorine pesticides. There are organizations such as World Wildlife Fund (WWF), which, largely through the work of Theo Colborn, raised the US government's awareness about endocrine disrupting pesticides. There is the Pesticide Action Network, which, through its advocacy work around the world on the 'Dirty Dozen' pesticides, has forced many countries to face the problems caused by acutely toxic and persistent pesticides.[49] Evidence of their foresight is revealed by regulatory actions like the US EPA's lessening of the registrational hurdles for safer alternatives to the hazardous pesticides. It is contended that, by involving people from organizations such as these in decision-making processes, the social, environmental and agricultural problems that are caused by pesticide use will be addressed more equitably and speedily than if these public interest groups continue to be omitted:

> It was community-based groups that advocated effectively for the children's environmental health agenda that is now on the table. They were correct to do so. It is also community organizations that lead the way in advocating for human rights concepts in the formulation of public health policies. We will need their help in addressing the challenges ahead.
>
> Buffler & Kyle 1999, p.A288.[50]

The argument of social values and expertise

Throughout the literature the discourses on risk, assessment, perception and public participation are pervaded with the notion that the public brings only social values to the table, whilst everyone else brings technical data (Tesh 1999, p.41). Many of the writers

[49] The Dirty Dozen pesticides are in fact eighteen pesticides grouped into a 'bakers' dozen of thirteen. For example, one group, the 'drins' contains three pesticides: aldrin, dieldrin and endrin. The other members of the Dirty Dozen are aldicarb, camphechlor, chlordane, chlordimeform, DBCP, DDT, ethylene dibromide, hexyachorobenzene, lindane, paraquat, parathion, methyl parathion, pentachlorophenol, and 2,4,5-T (PAN NA 1991). Of these eighteen, only paraquat and methyl parathion are still registered in New Zealand.
[50] Buffler & Kyle, School of Public Health, University of California Berkeley.

cited in this thesis take that view (e.g. Slovic, Fischhoff & Lichtenstein 1982; Otway 1992; Leiss 1996; Fischhoff 1996). Even those who recognize that there are legitimate knowledge systems other than positivist science still tend to regard the public's contribution as limited to that of social values (e.g. Charnley 2000). Perhaps that is why they have failed to conceive of public participation in the manner described here, as a significant factor in actual agenda-setting and decision-making, for as Tesh (1999) pointed out such an assumption "justifies limiting citizen participation" (p.53). As was described in Chapter 6, public interest groups can and do have technical expertise. They also can and do have community experience. Lack of expertise cannot be used as an excuse for preventing lay experts access to the policy process. Lay experts working for, or on behalf of, public interest groups may in fact be highly trained and qualified people, but are working outside the normal institutions that serve the status quo, perhaps because they do not adhere to technological rationality. They may be academics. Equally they may be self-trained and have long personal experience of the implications of pesticide use. If lay knowledge is to have standing within the policy process, as has been argued in Chapter 6, then those with that knowledge must be given adequate standing in the process. As Freudenburg noted:

> A growing body of literature has found that the opponents of technology tend to be just as well-informed as the supporters.
>
> Freudenburg 1996, p.21.[51]

Echoing the examples given in the previous chapter, Freudenburg commented that lay people have even become "reasonably skilled epidemiologists" in the search for answers. Bryan Norton too commented that:

> Regardless of questions of rhetorical style, Leopold and Carson set high standards for scientific objectivity [sic], standards environmentalists maintain today. Because their arguments, including Leopold's against atomistic management and Carson's argument from bioaccumulation, required premises of considerable generality, activists were forced to expose themselves to considerable risk that their premises might be undermined by further scientific data. While there are instances in which environmentalists have too quickly endorsed scientific generalizations, on the whole their arguments have scored high on the plausibility scale. Furthermore, while they outrun available data in some cases, they have been quick to correct any formulations that become scientifically questionable, and they have amassed an impressive number of victories

[51] Freudenburg cited nine examples from the literature.

> in administrative hearings and court cases that turned on complex scientific arguments.
>
> Norton 1991, p.84.

The same degree of scientific accuracy could not be ascribed to some of Carson's detractors: according to Norton, the chemical industry was moved by the publication of *Silent Spring* to question Carson's right as a "spinster" to raise concerns about future generations (Norton 1991, p.121). The real issue, of course, was not science or 'spinsterism', but moral values versus economic ones, for Carson's scientific arguments were generally well accepted by "disinterested" scientists (Norton 1991, p.122).

Support for the proposition that lay experts should play a prominent role in pesticide policy development and decisions comes also from Brian Wynne (1992). Wynne's work with Cumbrian sheep farmers affected by radioactive fallout from the Chernobyl nuclear explosion, and with the public controversy over the herbicide 2,4,5-T in the UK, led him to argue that risk assessment needs to "reconceive" itself "as being controlled intellectually by extended peer groups" (Wynne 1992, p.294), that is lay experts. He noted that this would require "institutional and political reorganization to give standing and influence to such extended networks" (p.294).

Thus it is argued that public interest groups need to be seated at the policy table to bring not only broad social values, but also technical data and community experience.

Reducing Remoteness

Plumwood drew attention to the need to reduce remoteness in a decision-making system in order to facilitate feedback of both ecological and social effects: remoteness not only from the direct consequences of the decisions, but also in a communicative and epistemological sense from news and knowledge of these consequences. It is contended that public interest groups and farmer/grower groups are best placed to reduce the remoteness that exists in a system in which decisions are taken by the bureaucracy alone, or in collaboration with business interests:

> When the remoteness from ecological harms of privileged groups most influential in decision-making systems meets a parallel silencing in the same decision-making systems of those most vulnerable to ecological harms, the social stage is set for major failures of ecological rationality.
>
> Plumwood 1998, p.565.

The concept of remoteness in this context involves distance not only from the damage caused by pesticides, but also from the knowledge about the effectiveness of non-

chemical pest management methods. It is important therefore that farmer/grower representatives include those, such as organic growing experts, who are able to provide this link.

It must also be noted that Plumwood (1998) dismissed the interest group approach to democracy as one which tends to allow "systematic redistribution of ecological ills to weaker groups" (p.570). However, it is contended that the constrained interest group model proposed here would mitigate against such a tendency as well as effectively reducing remoteness.

Replacing the adversarial tradition with collaboration

In essence, the proposal in this thesis is for a partnership approach similar to that proposed by Carolyn Merchant (1996) between human and non-human nature. In this case the partnership between human and nonhuman nature implemented via the ecocentric ethic that underlies the policy, is mirrored in a partnership within humanity—between users of pesticides and those affected by them.

Traditionally, the relationship between proponents of pesticide use and public interest groups is seen as one of adversarial conflict. Nowhere is this better illustrated than in the USA policy arena, which has seen environmental groups pitted against pesticide producers, with farmers and other users left with the little power in the lengthy, often legalistic, conflict (Bosso 1988, Nownes 1991). This has come about at least in part because many of the pesticide corporates are based in the USA and because many of the environmental groups are recipients of substantial funding from foundations with environmental interests (Nownes 1991, p.5-7). In New Zealand the debate is characterised by public interest groups on one side, including environmental, consumer, health and organic growers groups, with farmers, the pesticide industry and the bureaucracy on the other. Here, the industry lobby, although powerful and ever present, does not entirely overwhelm farming interests perhaps, in part, because pesticide manufacture is not a major industry in New Zealand.

It is contended that decisions about pesticides properly belong in the domain inhabited by farmers/growers and public interest groups rather than industry and environmental groups, for those are the sectors of society most influenced by those decisions. It is further contended that re-orienting the debate to one between farmers and public interest groups, and lessening the influence of the pesticide industry lobby in this debate will provide a less adversarial approach to pesticide policy. For the farmers and the public interest groups in fact share common ground, although this has often been

obfuscated by traditional hostilities carried out through the media. These hostilities have emerged, in part, because of neighbour anger at farmers whose pesticides drift across the boundary, but also because the pesticide industry has chosen to portray public interest groups as the farmers' enemy. In the end the public interest groups have no more desire for farmers to fail in the production of food than the farmers themselves have. Thus, the pesticide policy process that is proposed here has at its core a desire and an opportunity for the re-framing of the relationship between farmers and public interest groups. This will be by no means an easy process, for the established hostilities run deep and are characterised by more than differences in attitudes to pesticides: they include other differences in world views and political persuasions. Here the gender issue again reasserts itself: women predominate in public interest groups involved in pesticide issues, as was discussed in Chapter 3, but men tend to dominate farming businesses and farming interest groups in New Zealand. Additionally, the amicable relationship between farmers and the pesticide industry runs long and deep (Nownes 1991, p.2), and it can be expected that industry lobbyists will exert significant pressure and persuasion on farmer/grower representatives potentially involved in the proposed policy process. It is vitally important that this problem be recognised and addressed, or the process will not function adequately and the results delivered will not be those that are promised by an ethical process. The integrity of the representatives of user and public interest groups, and bureaucrats, will be addressed later.

Partial support for this collaborative approach can be found in the words of philosopher Mary Midgley:

> Moving away from Cartesianism, we may suggest that theoretical disputes as well as practical ones are best settled, not from on high, but by peaceful negotiation between the parties involved, with background help and advice from outside observers. When clashes arise, . . . the proper procedure is not for each party to try to knock the other down with a proof that its own view is wholly correct but for both parties, and anyone else involved, to work harder to understand each other.
>
> Midgley 1989, p.130.

Midgley was referring to disputes between theoreticians, but she may equally well have addressed her comment to the pesticide policy process. However, it is productive to think in terms of the pesticide policy process, not as a dispute requiring negotiation, but as a process of collaboration in which farming needs, social values and knowledge are brought together to achieve pest management which minimizes harm to the ecosystem including humans, but enables food and fibre production to flourish. Although at first

glance it would seem that setting up a policy process with pesticide users on the one hand, and public interest groups on the other is likely to lead to an adversarial approach to policy making (Busenberg 1999), it is contended that such an approach can, and must be, collaborative. Central to the success of this process must be the concept that is also a defining feature of the discourse approach of deliberative democracy, according to Dryzek (2000): that individuals participating in the process are "amenable to changing their minds and their preferences as a result of reflection induced by deliberation" (p.31). Eckersley (1999) provided a slightly different interpretation, that of participants defending "their proposed norms in terms of arguments that are public spirited and generalisable (rather than private, selfish and particular to them)" (p.27). In other words, a closed-mind approach that follows the strategic pursuit of entrenched individual goals and interests, such as is the thesis of rational choice theorists and which characterizes the USA interest group pluralism model, will not work. Participants must be able to pursue the public good rather than private strategic agendas. Renn *et al.* (1995) provided a description of the term 'discourse' that reveals other qualities that would benefit this process: equality among participants, peer review as a means for verifying understanding, and an orientation towards resolving conflict in a consensual rather than adversarial manner (p.3).

Experience with Auckland City Weed Management Policy has shown that exactly the approach proposed here can be successfully collaborative, resulting in the resolution of issues to mutual satisfaction.[52] In fact, a properly structured pesticide policy process that directly faces the objectives of the policy, rather than areas of conflicts, may be able to minimize conflict. If the process addresses the issue of effective pest management that minimizes damage to the environment rather than the risk assessment of pesticides, it can at once be seen that the two theoretically opposing sides in fact have a united purpose.

A comment on the decision-making procedure

Although the actual method by which decisions are made is an important aspect of the policy process, it is contended that it is secondary to the decision about who is involved and how they are involved, and hence it is only noted here in passing. As previously

[52] It should not be assumed from this comment that the Auckland City Weed Management Policy was arrived at without conflict. It was the author's experience that there was significant conflict within the consultative group that assisted the policy development. However, it must also be recognised that the policy process evolved a little haphazardly and without the clarity of process and underlying ethic proposed in this thesis. It was also a policy that arose out of intense community/authority conflict and distrust of thirteen years duration. It cannot be expected harmony and trust will be instantly engendered.

mentioned, this thesis does not cover every aspect of the policy process and policy tools that are available, but has instead concentrated on the four aspects that, it is contended, are the most vital underlying elements for successful, ethical policy making. There is a wide literature on improved ways of making decisions, including Habermas's (1971) conditions of ideal speech and practical discourse, Joshua Cohen's (1989) and Robert Dahl's (1985) accounts of procedure, decision analysis in place of risk analysis (e.g. von Winterfeldt 1992; Slovic 1997), and alternatives analysis (O'Brien 2000).[53] It is worth noting, also, one of Shrader-Frechette's (1991, p.206-7) conditions for achieving negotiation in a democratic manner is that the parties involved should be approximately equal in political and economic power, which means that public interest and farming groups need equal resources and hence access to experts, and staff.

Iris Young's (1990, 1995) work on cultural hegemony pointed out how the dominant Western deliberative norms "follow the strongly entrenched pattern of reason/nature dualism, privileging speech which is dispassionate and disembodied", according to Plumwood (1998, p.578). Communicative democracy, in which gender, race and class-based differences in speaking styles are accorded equal legitimacy, is another essential aspect of ethical policy development. These elements must be specifically attended to in the decision-making process for the power of the assumed 'rationalist' style will otherwise disenfranchise those who may have much to offer the policy process. This is an area in which the skills of the chairperson will play an important role.

In summary, it is important to remember that in devising this aspect of the policy process care must be taken that gender, technical and social differences are addressed so that certain elements are not disenfranchised by a process that overlooks their style and needs (Dryzek 2000).

Selecting the decision-makers

Considerable care must be taken in selecting the decision-makers within both the public interest sector and the farmers/growers sector. There are issues particularly of integrity, mandate, accountability and gender that must be considered, as well as expertise. There is also the issue of who should select them. It is contended that such choices, whilst lying ultimately with the bureaucracy, should be broadly agreed to be all those involved in the public interest group sector on the one hand, and the farmer/grower interests on the other. There must be genuine broad sectoral support for the decision-makers selected and they must be seen to be free from capture by bureaucracy or industry. They must

[53] See also Kemp 1993 and Renn 1992 for application of Habermas' approach.

also be willing and able to approach the task from a collaborative rather than an adversarial perspective. They must be willing to encompass the attitudinal changes that are required, and as were referred to in Chapter 5, in order to implement the ecocentric approach. These comments apply equally to the bureaucrats involved.

Integrity of representatives

The potential problem of pesticide industry influence on decision-makers must be closely monitored, particularly with respect to the interests of the farming representatives because of the traditional relationship between the two. It should be recognised, also, that it is possible that the industry will try to influence, even infiltrate, public interest groups. No specific remedy is proposed here, except watchfulness, transparency, accountability, and the promotion of the concepts of integrity and partnership.

One of the reasons for proposing that public participation be channelled through public interest groups is the desirability of community oversight and support for the process. It is contended that, because most public interest groups in New Zealand depend for their survival on support from the community in the absence of large donor foundations, there is a considerable degree of responsibility and accountability attached to them. This makes it significantly more difficult for individuals with personal agendas that do not reflect society's broader aims to infiltrate and subvert the process. This structure of interest groups mandated by the community provides a corrective feedback mechanism of the type found throughout nature and recognised by even the constrained modernist view of ecological rationality. It allows for feedback "from below" of social effects and values, a condition that Plumwood (1998, p.564) found to be necessary for ecologically rational decision-making.

Representativeness

It is vitally important in structuring such a process that elements of distributive justice be taken into account, to ensure that those marginalized under technologically-ordered processes do not remain so under ecologically-ordered systems (Plumwood 1998, p.579). For example, in countries like the USA where there is a large migrant labour force, poisoning by pesticides is a major problem. It is addressed by some organizations, such the Pesticide Education Center in San Francisco, but not be those that have a focus on environmental problems, for example WWF. There is little information available about any such problem in New Zealand, although it does potentially exist especially in the horticultural sector. New Zealand does, however, have a well recognized problem of distributive justice with spray drift. It is an issue not only of human exposure, but also of

horticultural crop damage and loss of organic certification. For this reason, the selection of policy group members in the third that represents pesticide users must be carried out carefully to ensure that those currently without rights do not continue to be marginalized.[54] Gender and race are other issues of representativeness, but have already been addressed earlier in this section.

7.4.2 Public participation and the ecocentric ethic

There is a tension between ecocentrism and democracy: as Dryzek (2000) pointed out democracy is anthropocentric (p.147). Liberalism is especially so, for it takes human interest as the measure of all value and accords standing only to "reasoning entities" (Dryzek 2000, p.147). This problem extends to the discursive approach of deliberative democracy and the participatory democracy of Green political theory (Dobson 1996, p.132-4), for as Goodin pointed out:

> To advocate democracy is to advocate procedures, to advocate environment is to advocate substantive outcomes: what guarantee can we have that the former procedures will yield to the latter sort of outcomes?
>
> Goodin 1992, p.168.

Connelly and Smith (1999, p.60-1) disagreed with Goodin, asserting that sustainable development is as much about democracy as it is about our ethical relationship with the non-human world. It is contended that both make valid points: democracy is essential, and so is the application of the ecocentric ethic, which it has already been argued is required in ethical policy. The exercise then is to ensure that democratic participation occurs in such a manner that the ethic is properly applied.

It could be argued that to stipulate the ecocentric ethic as the basis for the development of pesticide policy is counter to the general tenor of increasing democratization that is proposed here, that the policy actors should arrive at the appropriate ethic on which to base the policy rather than having it predetermined as is also proposed here. The model proposed in this thesis appears to be in direct conflict with the discourse ethic that underpins deliberative democracy. The discourse ethic, as developed by Habermas, primarily addresses the conditions of deliberation (Eckersley 1999, p.26). It has as one of its guiding principles the belief that "no *a priori* moral claims may be made about morality or ethics prior to intersubjective discussion by communicatively competent

[54] Organic growers are also pesticide users: several products that are permitted in certified production systems are registered pesticides, for example copper hydroxide, lime sulphur, and *Bacillus thuringiensis*.

subjects, save those which directly relate to the formal procedures of free communication" (Eckersley 1999, p.44). That would suggest that an ecocentric ethic should not be an *a priori* condition of an ethical pesticide policy process constituted under extended democracy, or rather that to do so is contrary to the rules of deliberative democracy. Such a suggestion is refuted, for it is contended that, unless an ecocentric ethic is specified, an anthropocentric ethic will be assumed and applied. It is not possible to have a pesticide policy based on neither one of these two ethics, at least until a third ethical approach unfolds, and as anthropocentrism is the dominant paradigm under which pesticide policy has been developed to date, it holds a position of unassailable power through the assumption of its 'rightness' inherent in its status quo position. It was argued in Chapter 5 that it is necessary, at the least, to acknowledge the existence of the underlying ethic being employed in the policy process. In an ideal Habermasian discourse both ethics would be the subject of debate.

However, the objective in this thesis is not to establish the 'perfect' democratic process, but rather to develop an ethical pesticide policy process. Part of that is to improve the democratic aspect such that it actually does reflect the issues and serve the needs of society relating to pesticides. It has already been argued in Chapter 5 that the most rational and ethically consistent approach to pesticide policy is that of ecocentrism, and that this is best given expression as a partnership between human and nonhuman nature. It would be irrational to ignore this finding in favour of satisfying Habermas's epistemologically derived criteria.

The second area of tension between ecocentrism and deliberative democracy also lies with the discourse ethic. The discourse ethic, as developed by Habermas, relies on 'communicative competence' to define standing and the lack of it in nature was used by him as the rationale for excluding nonhuman nature from consideration. Thus, whilst ecocentric theory incorporates participatory democracy, which broadly includes the discursive approach, this does not guarantee that decision-making will be ecologically rational and that nonhuman interests will be given standing consistent with a partnership approach. In fact it would probably have the opposite effect, given Habermas's attitude towards those entities that cannot speak the human languages. Thus non-human nature's interests must somehow be preserved in the policy process, without it having actual 'presence' in Anne Phillips's terms. Attfield (1999, p.193) reminded us that inherently the intrinsic values of nature have no standing because they cannot speak for themselves—unless specifically accorded that standing. They are provided that standing in the proposed process, both in terms of the specified ethic and in terms of the specified 'ecocentrist' to 'protect' that ethic. Environmental groups that

may form part of the public interest group 'third' should not be prevailed upon to be the sole defenders of the interests of non-human nature.

Recently democracy theorists such as Dryzek and Eckersley have begun to argue for the inclusion of non-human interests within the discursive approach to public policy. Eckersley (1999) dismissed Habermas's condition of communicative competency as being "arbitrary from a moral point of view" (p.46), as primarily epistemological (p 25), and not morally acceptable when the logic of the argument is extended to humans that are incapable of competent communication (p.37,44). She preferred, instead, a condition of self-directedness as a guideline for moral considerability (p.41). Dryzek argued that non-human nature should be incorporated into extended democracy through the discourse technique of communication, by extending the concept of communication beyond mere linguistic agency to include non-verbal communication. In this case communication consists of humans listening to nature:

> Recognition of agency in nature therefore means that we should listen to signals emanating from the natural world with the same sort of respect we accord communication emanating from human subjects, and as requiring equally careful interpretation.
>
> Dryzek 2000, p.149.

In a tentative approach to develop a model of ecological democracy, Dryzek (2000) argued that our relationship with the natural world "should not be one of instrumental intervention and observation of results oriented to control" (p.151), but did not elucidate what it should be beyond exercising the communicative capacity human and non-human nature share. It is contended that the proposal given in this thesis, for a policy process based on an ecocentric ethic incorporating a partnership approach and using the principle of minimum harm as a decision rule, may be the first step in reaching towards ecological democracy. It would permit a greater equality for nature by coming as close to Phillips 'politics of presence' as is possible, and combine this with the 'politics of ideas'. Further, this proposal finds support in Eckersley's (1999) argument that the precautionary approach may be used as a decision rule to "incorporate and 'represent' nature's interests in practical discursive arenas" (p.24), recalling that it has been argued in Chapter 5 that the precautionary approach best finds expression in pesticide policy as the principle of minimum harm.[55]

[55] Dobson's (1996, p.145) approach to this problem of ecological democracy was to argue that autonomy claims of non-human beings should be grounded in a theory of justice that has a naturalistic basis.

7.4.3 Support from Auckland City Weed Management Policy

Support for the proposal of a pesticide policy decision-making group comprising equal parts of bureaucrats, user representatives and public interest groups, and working on a collaborative basis, can be found in the development of Auckland City's Weed Management Policy, referred to already in Chapters 2 and 6. What is of importance here is the process by which that policy was arrived at and, particularly, who it was that developed it.

Firstly, to summarise the situation, public opposition to herbicide use had been steadily mounting from at least 1986 until the start of the policy development process in mid-1997. That opposition had been voiced by a number of citizens' organisations, by individual members of the public, a school, and by whole streets of residents. It took the form of telephone calls, letters, petitions, deputations, submissions, and the provision of expert witnesses, such as doctors and lawyers, to various Council meetings. Records reveal that, over that eleven-year period, the subject was discussed by at least four full Council meetings, twenty-four Council Committee meetings, and seventy-four Community Board meetings (Storer 1997).[56]

Two things become apparent from these figures. Firstly there was a large expenditure of Council time, and therefore money, on this issue. In addition to the meetings there were countless telephone calls and letters involving the time of both Council staff and Councillors (see, for example, Davis *et al.* 1998, p.31,32). Secondly there was a pyramid effect:

4 Council meetings

24 Committees meetings

74 Community Board meetings

100's of Community initiatives and actions

[56] These figures are derived from the summary of records provided by Storer (1997) as an Appendix to the Weed Management Policy (Davis *et al.* 1998). It may not be a full record of all Council meetings as Storer expressed some difficulty in accessing all the records. The Community Committee meetings have been included in those of the Community Boards here, for ease, and because the one turned into the other eventually.

A vast amount of effort was expended at the community level, but as the hierarchical pyramid was scaled, less and less of that community concern found its way into the minds of those who made the decisions, until in the rarefied air of full Council meetings the subject had been relatively rarely discussed. The filtering effect of the hierarchy had enabled the Council to effectively ignore the community concerns for a long time. The implications of this are obvious: the longer the community's concerns are ignored, the longer the conflict continues and the more money and time consumed by the issue needlessly. For the eventual outcome of the policy process closely reflected the concerns expressed by the community and the objectives they sought over the preceding eleven years. Those objectives had been variously expressed, but came down to one main issue: the cessation of all herbicide use by Council and its contractors in areas in which the public might be exposed to that spray. By far the bulk of that potential exposure occurred with roadside spraying, and to a lesser extent in parks (Davis *et al.* 1998, p.110). The policy eventually adopted by Auckland City Council included cessation of all herbicide use on roadsides, except for around some street trees, and a 75 percent reduction in herbicide use in parks and reserves by 2005, any continuing use of herbicides to be based on the principle that they are used only where there is no practicable alternative (Davis *et al.* 1998, p.8,9).

The manner in which the policy process eventually incorporated community concerns and achieved community requirements was vital to its success. In April 1997, the Council's Finance & Property Committee sought to save $50,000 from the Council's budget by phasing out the non-chemical 'steam' method of vegetation control that operated in some parts of the City, replacing it with herbicides (Storer 1997, p.14), despite the history of public opposition to herbicide use that has been recorded in Chapters 2 and 6. When the public interest organisation Toxins Awareness Group discovered this move, they alerted other groups and the wider community. The result was a number of submissions, deputations, and a petition presented to subsequent meetings. Realising the strength of feeling in the community the full Council overturned the resolution in May of that year and directed that a full report on weed management, including environmental and health issues, be prepared (Storer 1997, p.9,10).

What followed was an excellent illustration of how well the inclusion of public interest groups in policy development can work. A Weed Management Consultative Group (WMCG) was established. It was lead by Council officer Bryan Gould and included representatives from the three public interest groups who had been most involved with the issue: Toxins Awareness Group, Soil & Health Association, and Community Awareness of Pesticides. Additionally, a weed control contractor, an independent environmental researcher, and a council Sports Park officer with experience in non-chemical turf management were invited to join (Davis *et al.* 1998, p.13). The group was rounded out by the addition of a chemical residue analyst who had requested to be included. Two consultants with experience in the ecology of weeds and native bush, Alison Davis and Mark Bellingham, were contracted, and policy development commenced. Almost immediately concern was expressed by the Toxins Awareness Group at the apparent bias of the consultancy team, which had little knowledge of or interest in the community concerns about health effects of herbicides, and a greater personal interest in controlling weeds in native bush reserves than in reducing the public's exposure to herbicides. To redress the imbalance the Toxins Awareness Group insisted that this author, as the representative of the Soil & Health Association on the WMCG, be contracted as an additional consultant, specifically to ensure community interests were fairly addressed in the policy. Gould agreed this to, and policy development continued.

The process involved close communication between the consultants and the WMCG on each aspect of the development of the policy, from scoping the project and developing the methodology to agreeing to the wording of each section of the final policy document. It was a lengthy process, often fractious, but the end result was a policy on which consensus was reached. Achieving consensus was not always easy and required some give and take. For example, the three public interest groups initially sought complete cessation of herbicide use, including in parks and reserves, but eventually accepted a 75 percent reduction over five years for the latter areas, with the *proviso* that all ongoing use be on the basis of no practicable alternative—in other words intuitively applying a form of the principle of minimum harm. On the other hand, the chemical residue analyst was unhappy with the inclusion of opinions from general medical practitioners on the effect of glyphosate herbicide on those people who suffer from multiple chemical sensitivity. However, he eventually accepted their inclusion.

The policy was adopted formally by the full Council on April 16th 1999 with an emphasis on implementing first that part which relates to street environments, and with the allocation of the necessary financial resources. A maximum period of two years was

permitted for the required cessation of herbicide use in the street environment, but within four months 95 percent of weed management programmes in the street environment had been converted to non-chemical management. As reported in Chapter 6, section 6.2.2, there has been a significant reduction in complaints to council about weed control methods and the level of weed control.

This exercise has provided an excellent example of the inclusion of representatives of public interest groups in policy decision-making, not as a token effort, but rather as an effective voice in that decision-making. The various sides of the debate were represented and demands were modified in the face of conflicting objectives, yet the basic objectives of all involved were met. Those objectives were, broadly, that public exposure to herbicides be significantly reduced, that the effects of herbicides on human health be recognised, that standards of weed management in street and park environments be maintained, and that there be better control of weeds on a long-term sustainable basis in natural bush areas. A policy was developed on the basis of true community involvement and consensus, with remarkably little opposition. As reported in Chapter 2, only one objection to the policy has come from the public at the time of writing—from an organisation which represents farmers but is not involved in any way in weed management in Auckland City. In addition one of the twelve City's Councillors opposed its adoption for reasons that were difficult to pinpoint.

In conclusion, the Weed Management Policy appears to be operating very successfully in terms of the Council's requirement to control weeds and in addressing community concerns. It is contended that the policy was successful largely because of the manner in which community representatives were closely involved in the project at all levels, including ongoing implementation, and also because the Council was prepared to contribute extra financial resources to enable non-chemical management of weeds. It serves as an excellent example of the development of 'pesticide' policy by those interests most affected, in this case the community and those charged with weed control. It demonstrated the ability of all parties involved to move beyond previously adversarial stances and work in a collaborative manner to reach a mutually acceptable outcome. It stands as an illustration of the potential of the model proposed here, even though the process was not informed by the content of this thesis, and in fact evolved in a subconscious and haphazard manner.

7.4.4 Why not the pesticide industry?

Under the pluralist approach of the multi-stakeholder model of policy formation that finds expression in New Zealand's Pesticides Board and AVMAC, but not ERMA, the pesticides industry has firmly established seats at the policy table. The proposal in this thesis is for these seats to be filled instead by public interest organizations and those who need to manage insects, weeds and diseases. There are a number of reasons for excluding the pesticide industry from decision-making in an ethical pesticide policy process, some of which have been mentioned already in earlier chapters. These include the substantial public distrust revealed by attitudinal surveys reported in Chapter 2, and the use of fraudulent data and misrepresentation of data referred to in Chapter 6. Other reasons that will be expanded on here are those of inordinate power, influence and financial clout, the industry's integral involvement in the risk assessment process, and its ethical requirement to place profit above social interests. All of these reasons are interrelated.

> They must do what is profitable, not necessarily what is right.
>
> Montague 1999, p.295.

Quite simply, pesticide companies are obliged to maximize their profit in both the short term and the long term. As Peter Montague noted, once a corporation is publicly traded it must return a profit to investors, it must grow, and it must externalize costs to the maximum extent feasible (1999, p.295).[57] That is their duty to shareholders. Therefore, pesticide companies are not in a position to take anything other than a strongly biased role in the pesticide policy process. They cannot be expected to fairly weight farmers' needs, environmental interests and societal values, and then deliver a judgement independent of their corporate imperatives. This is particularly so where the principle of minimum harm is applied and they might be required to deny registration of a potentially profitable pesticide because of the existence of a practical non-chemical method of pest control that yields them no financial return. No matter how well meaning and honourable individual members of chemical corporations might be, they should not be required to make judgements that may financially damage their employees, employers, or shareholders. It is contended that to place representatives of the pesticide industry in such a position is unethical. Clearly, corporate imperatives are

[57] Montague, Environmental Research Foundation, Annapolis, MD.

at odds with the requirement of public policy to serve the interests of society as a whole:[58]

> Firms are concerned primarily with promoting *private* interests (maximising shareholders' profits), whereas nations are obliged to promote the *public* welfare.
>
> Shrader-Frechette 1991, p.158.

A second reason, which in fact arises out of the profit requirement, relates to the risk assessment process. Most risk and hazard assessments that support registrations are carried out by pesticide industry experts (Shrader-Frechette 1991, p.5) and, as was demonstrated in Chapters 3, 4 and 5, much of the data used and conclusions reached are subject to value-based judgements. This conclusion was also reached by Brunk *et al.* in the Canadian alachlor case referred to previously in this thesis. The authors noted that:

> Risk assessment is necessarily motivated and guided by an underlying framework of values, which influences the assessment by framing the process in a distinctive way, and . . . where there are substantial uncertainties in the science they readily lend themselves to strategic manipulation in a regulatory context.
>
> Brunk *et al.* 1998, p.68.

It has already been argued in Chapter 6, section 6.1.1, that rationality depends on assessing risks in a manner that is cogent with one's value system. It is therefore logical and consistent that the pesticide industry would manage the risk assessment process in a manner that protects its own interests. It is unrealistic, unfair and irrational to expect it to assess risk data from the basis of a set of values that may be directly to its detriment, leading it to suffer financial losses for the sake of the greater good of the society. Brunk *et al.* (1998) provided a detailed analysis of Monsanto's presentation of the scientific data in a manner which protected their own values, arguing that the company worked "strategically with the uncertainties in the data, making whatever assumptions were necessary at each juncture to reduce the calculated risk of alachlor" (p.68). For example, Monsanto argued that the risk assessment should be quantitative (p.62), thereby excluding nebulous values and benefits that could not be given a dollar value. They used exposure data from a best case scenario—application by their own employees—

[58] An indication on this problem can also be found in data reported by The Center for Public Integrity (O'Sullivan 1998), regarding the pesticide industry's 'burial' of adverse effects data. They asserted that "in 1991 and 1992, after the EPA offered amnesty from large fines to any manufacturer that turned in unpublished scientific papers that should have been submitted earlier, chemical companies suddenly produced 10,000 studies showing that products already on the market could pose 'substantial risk of injury to health or to the environment' (p.2).

rather than a worst case or even typical case scenario. This had the effect of dramatically reducing the estimated risk associated with use of alachlor. They argued that if the data do not demonstrate cancer then they demonstrate that there is no risk of cancer (p.64), even though the one does not necessarily follow from the other. The authors noted that Monsanto "used both relaxed and rigorous criteria of proof, depending upon how these tended to reduce the estimation of alachlor's risk" (p.65), as would be expected of any organization intent upon winning its case:

> Each of Monsanto's assumptions worked to decrease the calculated risk of alachlor's carcinogenicity.
>
> Brunk *et al*. 1998, p.66.

It is contended that the involvement in decision-making of corporate entities, whose business ethic requires or allows them to use scientific data in this manner, is not acceptable in ethical pesticide policy. Such involvement would not serve science well either. As Latin noted:

> The primary incentive of industry representatives is to minimize regulatory costs, not to promote "good science".
>
> Latin 1988, p.312.

A related aspect of the risk assessment reason is that the technical data used in the registration process is supplied largely by the pesticide industry. It is not ethical that the industry should subsequently stand in judgement of that data in determining the acceptability of pesticides. It is acknowledged that the proposal, in section 7.4.1, for the toxicological data to be provided by independent scientists rather than the pesticide industry, partially removes this argument, but leaves unaffected the ethical implications of the pesticide industry sitting in judgement of the data on their own products.

The third reason for excluding the pesticide industry arises from both the profit motive and the involvement in the risk assessment process, and that is the grossly unbalanced nature of the resources and power that they can bring to the policy process, when compared with the resources and political power available to farmers and public interest groups. As an illustration of this point, Montague (1999) pointed out that the annual turnover of many of the world's transnational corporations, some of which are pesticide manufacturers, exceeds the GDP of a number of countries. Montague likened a corporate's internal drive to that of a persons "will to live" (p.295), and if the human analogy is extended to Darwin's survival of the fittest approach to life, then it is evident that if the industry's power is given rein in a pesticide policy process the farming,

environmental and social interests will not survive. The influence of the pesticide corporates on policy in the USA is described by Christopher Bosso:[59]

> The House Agriculture committee's long-held jurisdiction over the regulations of chemical pesticides gives farm and chemical industry interests a tremendous advantage over environmental groups each time demands for wholesale policy change arise. Environmentalists may rail against committee members as mere defenders of some unacceptable ecological status quo, but their pleas more often than not are drowned out by the siren songs of constituents and their affiliated organized interests. This institutionally buttressed ability of narrow interest to screen out contrary views is replicated through out the congressional committee system.
>
> Bosso 1993, p.82.

Bosso's remarks were directed at the US political system. However, there is no reason to believe that a similar situation of power and influence does not exist in New Zealand. Indeed the Pesticides Board regards the pesticide industry as its clientele, and expresses its function as being one of providing a service to its clients, expediting efficient registration of pesticides. It could be argued that expelling the pesticide industry from the policy table will result in subversive influences on bureaucrats. As reported in Chapter 1, section 1.2.1, the latter are already subjected to heavy lobbying by the chemical industry. It is unlikely this would diminish under the proposed policy, and it may even increase. It is contended that such potential behaviour does not constitute an ethical reason for providing a seat at the policy table for the pesticide industry.

The interests with the greatest financial resources to hand are the ones that generally are able to influence the politicians to support their self-interested ends. That is not a value judgement: it is simply the nature of capitalism in a liberal democracy:

> Political and financial considerations brought to bear by the agrochemical industry commonly shape the direction of policy rather than the human health or ecological effects of pesticide use.
>
> Murphy 1998, cited in Watterson 1999a.

Perhaps this, in part, explains why there are still sixty one pesticides in use around the world that are known to cause adverse reproductive effects in laboratory tests, according to Watterson (1999b, p.14).[60] As mentioned in Chapter 5, section 5.3.3, it was the

[59] Bosso, Associate Professor of Political Science, Northeastern University, Boston, Massachusetts.
[60] Watterson cited Paul 1993, and Schettler *et al.* 1999; also nine papers by Helen Murphy of the FAO/IPM project in Indonesia dated 1996-1998.

petrochemical industry that was essentially responsible for the replacement of the precautionary approach in US law with the risk assessment approach, through the *Ethyl* and *Benzene* cases. Montague (1999) provided details of the petrochemical industry's manipulations of facts and opinions in the *Ethyl* and *Benzene* sagas. Baruch Fischhoff (1996) drew attention to the "invention" of risk assessment by the space, chemical and nuclear industries as a method of ordering the relative riskiness of alternative designs, noting that the process only obtained a public face "when the need arose to demonstrate the safety of chosen designs" (p.77). What that tends to indicate is that risk assessment is carried out for the benefit of the industry rather than for the benefit of the public, a contention that is lent weight by Fischhoff's (1996, p.76) observation that "inevitably, a field is shaped by those who pay the bills". It is also supported by Frederick Anderson's assertion that risk assessment provides "long term certainty for business investment" (1996, p.77).[61]

Thus, the final reason for the pesticide industry's exclusion that is visited here is the inordinate influence on pesticide policy it already enjoys through political and financial clout. This view is supported by Dryzek's assertion, reported earlier in this chapter, section 7.3, that the structure of a capitalist liberal democracy makes natural bedfellows of industry and government, the latter requiring the former to carry out its intentions. Such a relationship must be countered in ethical pesticide policy where the aim should be to serve society's needs for pest management that meets the requirements of food and fibre production, but in a manner that minimizes damage to human and non-human nature.

Conclusion

It has been argued in preceding chapters that the first two stages in developing an ethical pesticide policy process are determining the underlying ethic to be an ecocentric one, and then widening admissible knowledge beyond that of positivist science to incorporate lay expertise, community knowledge and experience, and wisdom. The next stage, and the final to be considered in this thesis, is determining whom it is that should be making the policy decisions within this new framework. It has been argued in this chapter that a tripartite approach be taken: equal parts public interest groups, those who need to manage pests, and the regulators who are ultimately responsible to the elected

[61] Anderson, attorney at Cadwalader, Wickersham & Taft in Washington, D.C.

politicians, with the addition of an independent chair and an 'ecocentrist' to protect and promote the implementation of the ecocentric ethic.

It has been argued that the deliberative democracy approaches of submissions, consultations, and opinion gathering are not sufficient mechanisms for ensuring society's needs are met, for they leave intact the decision framework that supports the technocentric and anthropocentric approach towards pesticides. The ecocentric ethic and admission of wisdom challenge not only the authority of science, but also the distribution of power under the current science-based policy processes. The pesticide industry has been deliberately omitted from the decision-makers for reasons that include lack of trust by the public, fraud and misrepresentation of data, a corporate ethic that requires putting private financial gain ahead of social good, a conflict of interest with regard to use of technical data, and power and influence in excess of the numbers of people involved in the industry. So too have scientists been omitted from the policy table, although scientists independent of the pesticide industry have been charged with the provision of toxicological data, on behalf of the government and at the pesticide industry's expense—to replace the current provision of that data by the industry.

On the other hand, it has been argued that farmers and growers must be involved in decision-making, including those with expertise in non-pesticide methods of pest management, because they are major 'recipients' of the policy: they are the people who must produce food and fibre under conditions of pest management that cause minimum damage to the environment. It has also been argued that lay experts are required to be at the policy table to represent the interests and knowledge of the wider community, to reduce remoteness from the impacts of pesticide policy, and as forward thinkers in recognising adverse effects of pesticides and innovative alternatives. Thus a direct participatory democracy approach is advocated: technocracy giving way to democracy

The point has been made that social equity issues must be considered in appointing decision-makers, particularly effects of distributive justice and gender. It has also been argued that removing the pesticide industry from the policy table and reorienting the objectives of the policy towards effective pest management methods that cause minimum damage, has the advantage of turning what were previously adversarial interests into collaborators, in a manner that will best meet society's and the wider ecosystem's needs and interests.

Finally, an example of a 'pesticide' policy process that evolved in a manner similar to that proposed in this thesis, albeit at the city rather than national level, was used to illustrate how effective the ethical pesticide policy approach can be.

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Conclusion

New Zealand's pesticide policy exists, partly, within a set of statutes: the Pesticides Act 1979, the RMA 1991, the HSNO Act 1996 and its regulations, the ACVM Act 1997, and to a lesser extent, the Health Act 1956, and the Health and Safety in Employment Act 1992. The Pesticides Act encourages the "prudent, effective, and safe use of pesticides" (section 13(a)). This Act, the HSNO and ACVM Acts all have the primary policy objective of facilitating pesticide registration, based on a premise that pesticides are desirable and on an assumption that they are needed. Further policy statements can be found in the HSNO requirement that risk assessment and risk management techniques be used to implement registration, and that cultural impacts be considered. Emphasis is placed on an approach that embraces economic utilitarianism underpinned by the instrumental rationality of science, with scant consideration of the ethical or, in reality, of the cultural.

Pesticide policy exists also as a presumptive right of pesticide users to drift spray across the boundary of the property on which the pesticides are being applied and into neighbouring private property and the wider environment. This right is supported by the RMA 1991, the Health Act 1956, and the Health and Safety in Employment Act 1992, in that they all require casual proof of adverse effects before an offence occurs, and that proof is virtually impossible to achieve in reality. The proposed HSNO regulations will confirm the presumptive right as a legal right for drift below toxicologically derived Tolerable Exposure Limits, but remove it for drift above those limits. The right to drift stems from the twin beliefs that it is not possible to apply pesticides without there being cross-boundary drift, and that it is not practicable to undertake agriculture without applying pesticides.

Pesticide policy exists in the failure of the regulatory mechanism to require those who use pesticides to pay the full costs of the externalities, and the failure to provide the consumer faced with purchasing food full information regarding the residues in that food and the wider effects of pesticide use. It exists in the bureaucrats' silences about organic agriculture, in the way that policies are named, framed and shaped. It exists in the language that is used, that of *expert assessment* and *public perception*, which creates a bias against the public's views and values. In order to reduce this unwarranted bias, the terms *technical assessment* and *lay assessment* have been used, instead, in this thesis. Finally, pesticide policy exists in the law courts' interpretation of Maori cultural principles in terms of scientifically derived estimations of environmental effects.

The true nature of pesticide policy has been revealed as that of social policy, involving a range of social issues and values, rights and entitlements that play a central but seldom acknowledged role in pesticide policy. The traditional approach to pesticide policy as a matter solely for technical deliberation, as a subject for the problem-solving, rationalistic, scientific models that tend to reduce social and political questions of values to seemingly technical matters, is rejected. The development of public policy has been shown to be a value-laden activity that carries consequences for all of society. It involves implicit and explicit judgements, and is constrained by the perceptions, values, biases and knowledge of those who develop it. It is contended that the ethical pesticide policy process must lay bare these hidden elements.

The ongoing conflict between pesticide users and the regulators on the one hand, and sectors of the community on the other, can be characterized by a significant difference in the assessment of risk by technical experts and by lay people. Underlying this difference there may be a whole variety of sociological, cultural and psychological factors. In addition to risk to an individual's health through direct exposure, spray drift, food and water residues, the public may also be concerned about environmental contamination. A person's deeper value systems may come into play, such as a desire for caution in the face of uncertainty, an intuitive unease with the concept of continuous application of small amounts of chemicals to the food chain, to human beings, and to the environment. There may be a distaste for many attributes of modern society that speak of self-interest above the interest of the community, of the attitude of domination, of the place which modern political power has awarded the economy.

Chapter 2 revealed a number of factors that influence the assessment of risk by the public. These include race, income, and education. However, the most striking influence was found to be that of gender. Men are likely to rate the risk from pesticides lower than are women. Significantly, this gender difference applies to both technical and lay experts. Chapter 2 also revealed that members of the public, and especially women, are more inclined to an egalitarian worldview, whereas the toxicologists that carry out the technical risk assessments are more likely to have a worldview encapsulated as 'technological enthusiasm'. They are hence likely to see less risk and greater benefit from pesticides than are the public. That is simply an expression of differing value systems, not of rationality or irrationality. What is often regarded as irrational is, in fact, perfectly rational when viewed against the background of values and ethics from whence it arose.

The failure to address the real debate behind the risk arguments, that of values, means that not only is the debate never resolved, but also that opposing views become further entrenched. The perception that the public is irrational lingers on, as does the perception that technical risk assessment provides *accurate* information on *actual* risk.

Thus the risk assessment process has also been a central focus of this thesis. It has been found to be based on a particular set of values than can be summarized as utilitarianism, mechanism, anthropocentrism and the domination of nature. Because the toxicological assessment of pesticides involves so few actual facts and such a degree of uncertainty and assumptions, there is considerable scope for those particular values to contribute significantly to the outcome of the assessment. As many as fifty discretionary judgements may occur in a normal risk assessment process. The assumptions require mathematical models in place of knowledge and judgements in place of fact, and these assumptions and judgements involve value systems. Failure to acknowledge these values, and their influence on the outcomes, undermines the claim to objective rationality. The effect of values on outcomes was illustrated by the range of estimates arrived at for the level of exposure to the herbicide alachlor. At one end of the scale those estimates established a significant risk of cancer and at the other end no risk at all. Whether cancer was a risk or not depended on the value systems of those involved in making the assessment, not on the actual properties of the herbicide. A crucial concern for the public, and hence pesticide policy, is whether or not these values accurately reflect those of society as a whole.

Toxicological risk assessment was also found to be incapable of accurately predicting the effects of pesticides on humans. It was found wanting in the face of the ongoing low dose exposure to mixtures of chemicals that is the reality of daily human existence. Several scientific studies and the medical information on multiple chemical sensitivity challenge the basic tenets of toxicology on which rest all risk assessments. Findings of inverse dose-responses challenge the tenet of a positive dose-response—the higher the dose the worse the effect, so that if the rat is not affected by a high dose in a laboratory trial, the human in everyday life will not be affected by a much lower dose. This rationale is used by some to discredit those who support the theory of multiple chemical sensitivity as an effect of chemicals. It is a situation that Thomas Kuhn (1962) would have recognized: if the evidence doesn't fit the comfortable convention, then throw the evidence out. Perhaps a paradigm change would be more useful in advancing the interests of society. The multiple chemical sensitivity paradigm seems to indicate that there may be no verifiable dose-response relationship for some people. It defies the traditional paradigm because low doses trigger large responses. Reality, in

terms of individual human variability, becomes injected into the risk equation as a significant third factor alongside hazard and exposure. Injection of reality into the risk equation may allow toxicology to better serve society's needs, and hence policy requirements.

Multiple chemical sensitivity is regarded by some as "one of the major scientific challenges of environmental science" (Cullen & Redlich 1995, p.1812-3), as a new paradigm for disease that has the potential to explain many chronic and costly illnesses, including fatigue, depression, headaches, and asthma (Ashford & Miller 1998). It is regarded by others as merely a psychological disturbance not caused by chemicals but by the disturbed psyche of the people concerned (Staudenmayer 1999). The finding that women are significantly more affected by the syndrome than are men added fuel to the 'neurosis' theory, although other researchers have pointed out that the hormone oestrogen is implicated in biological responses to chemicals. Whilst the debates and the research continue, the policy makers are left to decide how to deal with the problem. Taking no action until the scientists are in agreement, is a policy statement that gives primacy to economic interest over human health issues, although it is likely to come in the guise of science-based decision-making. Should policy rely only on the toxicological risk assessment process, a process that has been shown to be guided by a particular set of values and worldviews, and which has been shown to be unable to explain and incorporate human experience? Or should it instead be guided by human experience, using science to advise that process where it is able to, but not to determine the outcome of decisions. It is contended that it is the task of pesticide policy to reflect the reality of human existence, whether or not this reality can be validated by scientific positivism. Slavish adherence to scientific positivism is a policy statement that enables governments to ignore emerging issues, such as that of endocrine disruption, which may be threatening the fabric of society—a policy position which promotes the interests of the pesticide industry over those of society.

Ecotoxicological risk assessment was also argued to be inadequate at predicting the real effects of pesticides on the ecosystem and its inhabitants. It fails to acknowledge the interconnectedness of nature and hence to operate on the basis of ecological rationality. It can, using its reductionist processes, identify some ways in which particularly pesticides harm the ecosystem. But it cannot determine that a pesticide will not cause harm to the ecosystem.

The technical risk assessment process has, therefore, been found to be an inadequate basis for decision-making in an ethical pesticide policy process. It is inadequate because

it is dependent on implicit value systems that do not reflect those of society as a whole, which are not debated, and which deny the interests of non-human nature. It is inadequate because it cannot accurately depict the effects of pesticides as they are experienced in every day human reality, and at the same time denies the wisdom and experience of those that suffer the effects. It is inadequate because it fails to encompass ecological rationality. It is inadequate because it denies democracy.

There are plenty of people who believe that the salvation of risk assessment lies with increasing the 'expert' science input and diminishing the 'irrational' public's influence. They may well be right if the objective is to save risk assessment. However, it is contended, this is not the objective of an ethical pesticide policy. Rather the objective is one of enabling the management of pests, weeds and diseases within the agri-ecosystem, and in other situations, in a manner that achieves the necessary control but at minimal expense to the environment, including human health; and that is cognizant of societal values, including distributional justice, gender issues, and cultural considerations. This objective, it is contended, is consistent with ecological rationality, social rationality and scientific rationality. It is also consistent with an ecocentric ethic that rests on a partnership between human and non-human nature, recognizing the interests of all individuals—human and non-human. Risk assessment is not the best method for achieving this objective, as this thesis has shown.

However, there is a strongly ingrained attitude, especially in policy making circles, that society must base its decisions on risk assessment because there is no other 'rational' way. The following comment from Latin illustrates this common misperception:

> Environmentalists attack the risk assessment process because they believe it frequently produces unreliable estimates of toxic hazards and because it is subject to manipulation by industrial dischargers and government bureaucrats. However sympathetic one may be to these objections, which surely have ample basis in past regulatory experience, society cannot feasibly eliminate all carcinogenic risks nor enjoin use of all toxic substances. Society must therefore develop some rational method for deciding which risks are unacceptable and for allocating scarce regulatory resources.
>
> Latin 1988, p.319.

This kind of comment is not unusual. It is important to note that Latin inferred agreement with 'environmentalists' criticisms of risk assessment, but then made the quantum leap to the defence of the process because society needs to use toxic chemicals. On the way, he missed the point that there may be other ways of regulating chemicals

besides risk assessment. As has been made very plain in this thesis, one of the most fundamental problems with the risk assessment process is that it asks the wrong questions, or rather not all the right questions. It only asks how safe is this pesticide, and are the risks justified in the light of potential benefits? It fails to ask the primary policy question about whether or not the pesticide is needed in the first place, or if are there less harmful ways of achieving its purpose. Until a pesticide policy process begins with that question, it cannot lay claim to either rationality or an ethical approach. Only when a pesticide policy sets its primary objective as that of managing weeds, pests and diseases in a manner that enables the necessary production of food and fibre, whilst causing the minimum harm to the environment, including non-human nature and humans, including health effects, cultural and social values, can it be regarded as rational and ethical. In such a process alternatives assessment, which includes some aspects of risk assessment, replaces traditional risk assessment. Perhaps the new process should be called 'needs assessment' to indicate the shift in emphasis from that of acceptance of risk to demonstration of need if there is a risk involved.

Thus, the ethical policy process has different knowledge and information requirements to those of the traditional policy process based on mechanistic risk assessment. It needs to know about distributional effects. It needs to know what are the actual effects of pesticide on both humans and on the environment. It needs to know the potential hazards of a pesticide before it is registered, and it needs to know if there are less harmful ways of achieving the required pest, weed or disease management. It was argued that the ethical pesticide policy process needs wisdom, which involves common sense, experience, intuition, emotion, contextual and holistic thinking, and which can provide profound insight and broad foresight. It needs the expertise of public interest groups with understanding of the social impacts and the actual physical effects of pesticides, and it needs the community experience of those effects. It needs toxicology to identify the hazards to humans and other inhabitants of the ecosystem that are inherent in each pesticide. And it needs the knowledge of farmers that manage their agri-ecosystems without the use of hazardous chemicals.

Thus, it was argued that the ethical pesticide policy process must encompass a significant injection of lay knowledge and expertise both in the area of the effects of pesticides and in the management of agriculture without them. This argument provides two major challenges to positivist science: it challenges its objectivity, and it challenges its authority to determine the way in which problems should be defined in the policy arena. It challenges the institutional power of expert knowledge and of experts, and their control of pesticide policy. It is not science that is being rejected here, but rather scientism as

defined by the Oxford Dictionary: "the excessive belief in the power of scientific knowledge and techniques" (Brown 1993, p.2177).

It was then argued that in an ethical pesticide policy process, just as technological rationality must give way to ecological rationally, and an anthropocentric ethic to an ecocentric ethic, so too must technocracy give way to democracy. The rule of technological in pesticide policy must be replaced by democratic involvement of the people affected and those who can represent their interests. The submission and consultation processes that are passed off as public participation were found to be inadequate because this form of 'participation' is advisory only, leaving intact the decision framework that supports the current technocentric and anthropocentric approach towards pesticide use.

A new policy decision-making group was devised and described as an 'augmented tripartite model'. The policy group consists of equal parts public interest groups with experience in and knowledge of social, cultural and physical effects of pesticides; those who need to manage pests, including the users of pesticides and those with experience in agri-ecosystem management without them; and the relevant bureaucrats. There are two additional people involved: an independent chair and an 'ecocentrist' charged with protecting and promoting the implementation of the ecocentric ethic, primarily through the principle of minimum harm. The inclusion, at least initially, of the 'ecocentrist' is a recognition of the need for significant attitudinal changes in order that ethical pesticide policy can be formulated and implemented successfully.

The pesticide industry has been deliberately omitted from the decision-makers for reasons that include lack of trust by the public, fraud and misrepresentation of data, a corporate ethic that requires putting private financial gain ahead of social good, a conflict of interest with regard to use of technical data, and political power and influence in excess of the numbers of people involved in the industry. So too have scientists been omitted from the policy table, although scientists independent of the pesticide industry have been charged with the provision of toxicological data, on behalf of society and at the pesticide industry's expense. The removal of the pesticide industry from the policy table, it was also argued, would facilitate changing what were previously adversarial interests into collaborators, in a manner that will best meet society's, and the wider ecosystem's, needs and interests.

Additionally, it has been asserted that the composition of the policy group must reflect gender and cultural issues. Because of the significant gender differences in the way that

pesticides are assessed, both by lay and technical assessors, and the gender differences in the physical effects caused by pesticides, the policy group must consist of at least 50 percent women. It has been argued also that Maori must make up 50 percent of the policy group because New Zealand is theoretically a bi-cultural nation and there are significant cultural differences relating to the effects of pesticides. As Maori constitute less than 20 percent of the population, involving them on a proportional basis automatically disenfranchises their cultural views and fails to implement the bicultural ethic. Such, it would appear, might be the current experience with ERMA, where Maori views on genetic engineering have been overruled, apparently as a minority consideration, by economic interests.

In summary, three procedural measures have been recommended here:

1. Establishing the ecocentric ethic as the underlying ethic on which pesticide policy is built. This ethic requires the consideration of the physical, cultural and social needs of all humans, and of the intrinsic interests of non-human individuals, communities and ecosystems. It must address issues of societal values and distributive justice. It requires a recognition of the interconnectedness of all elements of nature and the implementation of the precautionary principle, through the decision rule of the principle of minimum harm. This principle provides for utilizing the pest management techniques and systems that cause the minimum harm to the ecosystem, including humans, but that enable humanity to manage pests in a manner that provides food and fibre to meets its needs.

2. The inclusion of lay expertise and community experience, incorporating the areas of societal values, actual and potential effects of pesticides, and knowledge of the management the agri-ecosystem without hazardous chemicals.

3. An augmented tripartite policy decision-making body that involves those who lie in the path of the policy, i.e. the community and the managers of the agri-ecosystem, working together in a collaborative manner to achieve the objective of the policy: food and fibre production with minimum harm to the ecosystem. The policy group is required to have equality of gender and culture, Maori and pakeha.

All of these measures are interrelated, and all are necessary for the successful development and implementation of ethical pesticide policy. If one is removed and only two allowed to function, the process is likely to fall short of its objectives.

The fundamental belief that risk assessment is a rational method of decision-making, and therefore all others must be irrational, is a profound error in thinking that has no basis in rationality. It is an outcome of the propaganda of scientism that has clouded otherwise intelligent minds and diverted their attention away from wise decision-making and from asking the very first question: what is it that we wish to achieve? With respect to pesticides, the ethical answer to that question must be management of the agri-ecosystem in a manner that produces sufficient nutritious and healthy food in a manner that causes minimum harm to the environment and which maximizes social and cultural justice and economic sustainability.

The emphasis in this thesis has been on process to the almost total exclusion of content, with the exception of the determination of an ecocentric ethic applied through the principle of minimum harm, as the basis for the policy. It is presumed that once the process is made right, the product will also be right. But Val Plumwood (1998) sounded a warning about "the reciprocal corrigibility that must hold between process and product" (p.579):

> We may need to decide if a process is working well by seeing if it is turning out the right sort of product.
>
> Plumwood 1998, p.579.

In other words, the quality of the product can act as a test for the process. If the pesticide policy that results from the process described in this thesis fails to meet social and ecological needs, then there is a failure in the process that needs to be addressed. That does not mean that the process itself does not have value, but rather than it may need refinement. The process for the development of the Auckland City Weed Management Policy, described throughout this thesis, incorporated some of the suggestions put forward here, although in a somewhat unpremeditated manner. In particular, it incorporated lay expertise and community experience, and a version of the principle of minimum harm expressed as using chemical herbicides only where there is no practicable alternative. The resulting policy would appear to be a success. It is recommended that the ethical pesticide policy process developed in this thesis be trialed in its entirety.

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Appendix 1 Auckland City Weed Management Policy: Overview of Public Attitude

The following information is extracted from Appendix Two (Storer 1997) of Auckland City's Weed Management Policy (Davis, Bellingham & Watts 1998), and as such it represents a synthesis of the information available in the Council files. It is not a complete account of public involvement, for not all representations to Committee, Board, and Council meetings were fully reported in a manner that revealed their real intent. Such a situation may be ascertained from the Community Boards' reports of public concern and the lack of detail regarding that concern.[1] Additionally, the summary does not include phone calls and letters sent directly to council staff. The collation of information is further complicated by the fact that prior to 1989 a number of separate borough and city councils existed in addition to Auckland City Council, but in 1989 were absorbed into the latter. Storer's synthesis does not include the pre-amalgamation borough and city councils because of difficulty in accessing their records. Nevertheless, these Councils were faced with resident complaints about herbicide spraying, and information relating to complaints received by Ellerslie Borough and Tamaki City Councils is included for illustrative purposes. The information is presented here in chronological order, beginning with the first record of the subject arising at a council's meeting, in 1986.[2] Unless otherwise indicated the information is drawn from Storer 1997.

1986

A resolution was passed by the Combined Community Committees "that an investigation be made with regard to the use of toxic sprays in public parks and street lawn verges—as an alternative—the use of non-toxic sprays be given trial experiments" (Storer 1997, p.32). There is no indication of the level of public concern that resulted in this resolution, but it is unlikely that such a resolution was proposed without prompting from the community.

1987

The St Heliers/Glendowie Community Committee resolved that the City Council "exercise closer control of all chemical herbicide sprays" and "reassure this committee

[1] See, for example, Grey Lynn/Westmere Community Board in 1987 in Storer (1997, p.32), where the comment is made that "Agenda Item 2 included weed spraying".
[2] Storer presented the information in hierarchical order (i.e. full council, committees, boards, etc) and in geographical order, relating to specific communities.

that existing sprays are non-toxic to humans and animals" (p.33). This resolution was followed by three public submissions at subsequent meetings in the same year expressing concern at herbicide use.

In September the Auckland City Council Parks & Recreation Committee received a deputation from Toxins Action Group expressing concern about weed spraying practices (Bradbourne & Morris 1998).

1988

Grey Lynn/Westmere Community Committee received complaints about herbicide spraying from the residents of four streets.

Remuera Community Committee received a submission from Toxins Action Group expressing concern about herbicide use.

Ellerslie Borough Council suspended all herbicide spraying pending an investigation into adverse health effects, following representations by parents and teachers from Michael Park School and from members of Toxins Action Group (Sheilds 1988; Ellerslie Borough Council 1988; Bartrom 1999).

Tamaki City Council Works Committee received a deputation from a resident concerned about herbicide spraying (Macdonald 1998). Tamaki City Council then noted that herbicide spraying was causing concern to many local authorities and referred the matter to the Auckland Local Bodies Association (Macdonald 1988).

Waiheke County Council received a petition of 1029 signatures[3] from Waiheke Toxins Action Group and seventeen individual citizens, together with four letters of concern from local educational institutions and a 200 page report about roadside spraying. The Council, at that time a stand-alone authority but subsequently absorbed into Auckland City, responded by establishing a seven-year moratorium on all herbicide spraying on Council administered property on the Island. It also resolved that non-chemical methods be implemented, but lack of attention to this part of the resolution resulted in seven submissions, over the period 1993-1995, from members of the public concerned about weed growth resulting from the apparent failure of non-chemical methods, and hence supporting use of herbicides.

1989

[3] About one third of the total number of residents on Waiheke Island at that time.

Blockhouse Bay Community Committee received correspondence from a resident regarding spray drift and subsequent effects on non-target plants.

1990

Grey Lynn/Westmere Community Committee raised health issues relating to herbicide spraying. Western Bays Community Board received public submissions (number unknown) and a street petition of twenty-five signatures expressing concern about herbicide spraying in public areas.

1991

Western Bays Community Board received a submission from the Grey Lynn/Westmere Community Committee on residents' concerns about herbicide spraying.

1992

Three residents concerned about herbicide use addressed Maungakiekie Community Board (Nixon 1992; Storer 1997).

1994

Auckland City Council received two submissions to the draft annual plan in support of non-chemical methods of weed control.

Concern was expressed by members of the public (number unknown) to the Maungakiekie Community Board regarding use of herbicides in Michaels Avenue Reserve. The Board requested Council to cease using "toxic chemicals on its grounds and facilities" (Storer 1997, p.40).

Mt Albert Community Board received submissions from four members of the public concerned about the use of herbicides in parks. The Board issued a report regarding the level of public concern about herbicide use, and recommending a chemical reduction programme for parks. All eleven Community Boards subsequently supported the programme.

Avondale Community Board resolved, in regard to weed control, " that the Board would prefer all of the ward to be chemical free" (Storer 1997, p.35). Later in the year one complaint about spraying was received from a member of the public.

Mt Eden Community Board received a complaint from a member of the public about herbicide use, and the Board requested that the Council's Works & Services Committee consider non-chemical methods (in particular the Waipuna steam system).

Western Bays Community Board received two submissions from members of the public expressing concern about herbicide spraying.

The Maori Representatives Committee passed a resolution to ask Council how its use of pesticides "can conflict with Maori cultural values and imperatives (e.g. kaitiaki); and to seek a policy commitment from Council to vigorously pursue alternatives" (p.31).

1995

Auckland City Council received one submission to its draft annual plan in support of non-chemical weed control. In July the Waiheke Community Board received five public submissions supporting continuation of the moratorium. In August it received forty submissions from individuals, six from groups, and two petitions, one of 1,000 signatures and one of sixty-one signatures. Both petitions and thirty-six submissions supported non-chemical weed management; twelve submissions supported herbicide use. The moratorium was extended indefinitely, slightly altered to allow selective spraying in bush reserves with permission of the Board, but with all herbicide use to be phased out by the year 2005.

1996

Auckland City received six submissions to the draft Strategic Plan, of which four supported non-chemical weed control, one supported herbicides, and one was concerned with weed growth and tidiness. On May 6th, Waiheke Community Board received thirteen public submissions, all opposing proposed herbicide use on a road reserve. On May 29th the Board received a further twenty public submissions regarding a proposal to use herbicides in three bush reserves, seventeen opposed to the herbicide use and three in support of it. In June it received four submissions supporting non-chemical weed management.

1997

Waiheke Community Board received eight submissions opposing the phasing out of the Waipuna steam system for weed control, and two more supporting an increased budget for non-chemical weed management.

On May 1st Auckland City Council received deputations from Michael Park School, Toxins Awareness Group and Society Targeting Overuse of Pesticides, together with a petition containing 249 signatures of Western Bays residents, all in support of non-toxic weed control. On July 10th the Council received a petition from Toxins Awareness Group of 6,519 signatures, requesting that "Auckland City Council stop all chemical weed control" (Storer 1997, p.11). In June it received the following submissions to its draft annual plan:

- nine of eleven Community Boards in favour of non-chemical weed control;
- submissions from Waiheke Grey Power, of which 669 were in favour of non-chemical weed control, and 179 were in favour of herbicide use;
- submissions from fifity-one individuals, forty-nine of whom supported non-chemical weed control, and one of whom supported herbicide use.

Council staff received three letters indicating support for herbicide use, and two letters and a petition of fourteen people from one street opposing it. The Council then resolved to undertake a "comprehensive investigation into weed management problems" (Davis *et al.* 1998, p.1).

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Appendix 2 Pesticide Hazard Scoring System

The hazard scoring system described below was developed for the purpose of setting targets for the reduction of *hazard* relating to pesticides, as opposed to *risk* or *quantity* of pesticide used. The system was designed to be used as part of a national pesticide risk reduction strategy. The use of risk indicators was argued to be an inadequate approach to take, principally because of the paucity of accurate data on exposure, as has been argued in this thesis. Table 1 below lists some of the exposure factors that would need to be considered in a risk indicator. These factors were identified at an OECD workshop on risk indicators for pesticides (Watts 1997a).

Extract from: Watts MA. 1997b. Proposal for a pesticide risk reduction policy for New Zealand. *Proc 50th N.Z. Plant Prot Conf* 1997:498-505.

The author proposes that, in the absence of adequate exposure data, New Zealand develops a total pesticide use hazard scoring system which would provide a quantitative target for reduction, and which would provide a policy feedback tool appropriate to our current level of data and knowledge—a method of stimulating and measuring a reduction in the hazards associated with pesticide use.

Table 1 Some exposure factors to consider in a pesticide risk indicator

Total quantity used	Residues in food and drinking water
Area treated	Dietary intake
Application rates	Processing information
Frequency of application	Number of users
Formulation	Level of training
Crop type	Use of protective clothing
Timing of application (eg crop stage)	Type of packaging
Method of application	Climatic factors
Tank mixture combinations	

Source: Watts 1997a.

The purposes of the Hazard Scoring System (HSS) are to compile quantitative indicators of hazards associated with pesticide use, to monitor changes in these over time, to encourage a change in attitude and behaviour to bring about a reduction in risk from pesticide use, and to provide a policy corrective mechanism. This model is therefore

intended for use at a national level, not at a crop level; it is not a tool to assist individual farmers use choices like those of Reus (1993) and Penrose *et al.* (1995).

Hazard indicators

Indicators of hazard are required for each of the two principal areas at risk from pesticide use: human health and the environment (including the agri-ecosystem). Table 2 identifies those proposed for the HSS, based on those considered by participants at the 1997 OECD Pesticide Risk Reduction Workshop to be of importance in a risk reduction indicator.

Table 2 Proposed indicators for a Hazard Scoring System

Human Health	Environmental
Acute oral, dermal and inhalation	Earthworms
Skin and eye irritation	Beneficial insects
Sensitisation	Bees
Subchronic and chronic NOELs	Aquatic plants, invertebrates, fish
Endocrine disruption	Birds
Neurotoxicity	Non-target terrestrial invertebrates
Immunotoxicity	Secondary poisoning
Carcinogenicity	Soil micro-organisms
Mutagenicity	Bioconcentration
Reproductive effects	Persistence in soils
	Leaching potential

Source: Watts 1997a.

Scoring mechanism

It is not the intention of this paper to develop the mechanics of the system, but rather to propose the overall concept of its use within a policy framework. Hence only a brief outline of a proposed scoring mechanism is provided.

Each pesticide is allocated a numerical score for each indicator of hazard, based on a predetermined scale. The scores are summed to provide a total hazard score for each pesticide in two separate categories—health and environment. Each of these is multiplied by its total use volume to provide a total hazard figure for each pesticide in the two separate categories of health and environment. All pesticide total hazard scores

can then be summed to provide an overall unitless figure for hazard to New Zealand's health and the environment.

Although it would be mathematically simple to add the hazard scores for health and environment to achieve one figure, this would presuppose that the two categories are of equal merit, that the initial scoring scales are equivalent, and that there are the same number of hazard indicators for both. Any other method of combination would require a societal decision on the relative importance of the health and environmental hazards. Such a decision would, of course, have to be very transparent, and very cooperative. Additionally if the scores for the two components are retained separately, it is possible to ascertain that over time one component is not increasing as the total decreases, disguised by the greater decrease of the second component.

The target

The dual scores for hazard to health and to the environment could then be used to develop targets, with timed reduction phases, designed to drive attitudinal and behavioural changes. If the estimate of today's hazard were to be say 20,000 units then a policy could develop a risk reduction goal of reducing that hazard score by 50% in 5 years, for example.

If the quality of pesticide use data were to allow it, total hazard scores could be retained separately for agricultural/horticultural, urban and utility usage. This would improve the effectiveness of the tool in focussing attention on areas where improvements are most needed. Such a focus may have an advantage in stimulating changes, as well as directing policy.

Problems

One of the greatest challenges to all scoring systems is the availability of accurate hazard data, especially in the ecological area. There are three separate issues, each of which challenge the accuracy of the systems in different ways:

- Lack of data on the interactive and long-term effects of pesticides at ecosystem levels, the hazards relating to so-called inerts and adjuvants in pesticide formulations' and to mixtures of pesticides.
- Lack of data for some pesticides with respect to those hazards that have been included in the scoring system. Several countries have increased their registration requirements for toxicological data, and it is likely that greater pressure will be

exerted both for these datasets to be expanded and for other countries to follow suit. Meanwhile, options for handling this situation include awarding an arbitrary and high/median/low score for that hazard, or an estimate based on structure and activity.

- Even where data is available, variations in test protocols of different research laboratories may limit the validity of comparisons (Levitan *et al.* 1995). However the OECD's project to harmonize pesticide registration procedures and standardize laboratory procedures may improve matters. The future outlook, therefore, is for a greater availability of standardized data relevant to an increased number of toxicological and ecotoxicological impacts of pesticides.

Perhaps an even greater challenge to the use of a scoring system in New Zealand is access to adequate use data, even at a national total use level. Such data is not, however, completely lacking, and until better collection is achieved, either mandated by regulation, or with the voluntary assistance of the chemical and agricultural industries, then estimates would need to be made on the basis of available information.

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