UK Pesticides Policy –
A policy paradigm in transition?

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March 2009

Volume 2

8. Findings from stakeholder interviews

8.1. Introduction

This chapter presents the results of interviews carried out among representatives of the pesticide policy network of the UK plus a few representatives from the EU policy network[59]. The background to the interview questions and how they relate to the research findings is explained in the Chapter Three. Each of the following three sections has an introduction covering the main areas discussed, followed by the interview responses with comment, and ends with a summary of key findings. The chapter also includes informed comment rather than just distilled interview findings.

The data are presented in a way that addresses the conceptual framework and the research questions for the present research. This includes the emergence of a dominant pesticide paradigm that has a pesticide policy community composed of a small and strong group of stakeholders that develop and defend the use of pesticides within a pesticide policy paradigm. From the 1960s onwards the pesticide paradigm has been criticised by critical stakeholders that has led to the creation of a pesticide policy network that includes both productive supporters and critical stakeholders. Concern about the adverse effects of pesticides has led to an increasingly stringent regulatory risk analysis process that has placed further pressure on the pesticide paradigm. Biological pest control products are emerging as one response to the pressures on the pesticides policy paradigm. The conditions are in place for a fundamental paradigm shift for these alternatives to be part of an ecological pest management paradigm; or they could be subsumed within the existing dominant pesticide paradigm.

The first data section of this chapter (Section 8.2) presents findings covering discussion around pesticides and risk. This includes an assessment of the precautionary principle that considers a wider range of options, uncertainties, disciplinary contributions and socio-cultural perspectives that extends the knowledge base for pesticide appraisal. Conventional risk assessment, on the other hand, takes place within a closed range of specialist perspectives. This includes a comparison of the UK technocratic risk analysis model with the more developed EU inverted decisionist approach (see Sections 2.2.2-3). Much of the stakeholder comments surround the difficulty of separating technical risk assessment from the political risk management section of the risk analysis process.

59. This included one EU regulator and one pesticide industry lobbyist. Many other interviewees had dual UK/EU responsibilities.

The next section describes the concerns raised by those who challenge and question the use of pesticides, and explains how they are addressed by others. This information is complemented with a review of the data on pesticides and consumer opinion, which had not been canvassed as part of the present research.

The following section presents comments about the introduction, development and use of bio-pesticides as alternatives to synthetic pesticides. This includes the regulatory and market barriers which have traditionally stifled bio-pesticide development. The concluding section summarises the prospects for an ecological pest management paradigm.

The last three sections (8.3-8.5 have a summary of the main results at end of each section. The Key Findings are present in the Discussion Chapter (Nine) so that they can be read after the review summaries, and immediate before the research conclusions.

8.2. *Risk analysis*

This section presents the findings from the interviews concerning the risk analysis of pesticides, an integral part of both the UK and EU regulatory processes. Risk analysis plays an important role in deciding whether pesticide use is acceptable. In the context of the present research it is used to support a pesticide paradigm. For the UK the processes of risk assessment and risk management are indistinguishable and follow a technocratic model. The EU model on the other hand separated the two. What can one infer from this difference? The precautionary principle (on some but not all interpretations) is an inclusive and transparent approach which attempts to accommodate scientific uncertainty into the risk analysis process. Interviewees had a range of views on this subject. There is a difference in responsibility and input between members of the pesticide policy network and the representatives of the regulatory processes.

Risk analysis is important because it underpins the regulatory process for pesticides. The regulatory process is controlled by the policy community element of the pesticide policy network. The risk analysis input from regulatory interviewees covered the way in which pesticides are approved. This is important because criteria that are adopted present a gateway for pesticides to enter the market. The regulators support a risk analysis process which has been criticised in the interviews by critical stakeholders. One way of analysing these differences is to use the precautionary principle. It has been embraced (at least rhetorically if not substantively) into UK and EU environmental policy, and making it workable remains a challenge.

Experts acknowledged that they have difficulty in explaining the complex set of issues presented by pesticides. They felt that that there was a lack of understanding about pesticides among the general public, and reassurance was just a question of more effective risk communication. The scientific uncertainty in estimating exposure to pesticides was raised by public interest groups as a reason for concern. This centred on issues such as the possibilities of chronic effects, pesticide mixtures, and the fact that there is a lack of expert agreement. A lack of trust in government and experts among civil society was also an issue. The relative emphasis in decision making between politics and science was disputed. The pesticide industry considers it right that the process is science-dominated. Regulators acknowledge that the process is science-informed but, in the final analysis, the decisions are political. Public interest organisations tended to use the science-based arguments to justify their

positions, although there were concerns about the closeness between the pesticide industry and the regulator.

8.2.1. The Precautionary Principle

The precautionary principle is sometimes interpreted as a mechanism that has the potential to accommodate politically contested technical issues. One of the interview questions specifically invited comments by asking: "What is the role of the precautionary principle for the control of pesticides?" (see Table 3.2, Vol. 1, page 95). This question was asked because it provides stakeholder feedback on an aspect of the risk analysis debate that is controversial and subject to contention between members of the pesticide policy network. A number of interviewees made critical references to the principle unprompted, which is an indication of the importance they place on it.

There are many definitions of the precautionary principle, as outlined in Vol. 1, page 43, which means it is a contested and controversial term in health and environmental policy spheres (Santillo et al., 1999). It has also moved from a position in the science and legal realms to become more politicised in consumer protest, in changing public perceptions of science, and in the social responsibility of corporations (O'Riordan et al., 2001: 9). The polemical views were reinforced by the interviewees during interview. A summary of responses is presented to provide an overall view, followed by more detailed analysis.

An overview of comments concerning pesticides and the precautionary principle are presented in Table 8.1. All the public interest interviewees were supportive of the Precautionary Principle, except one who felt it did not go far enough (rather than being excessive). At the other end of the spectrum the pesticide industry commented negatively about the principle, or considered that further application was not necessary because current measures were already precautionary enough. Other interviewee groups represented a mixture of views. Some of the multiple food retailers were supportive because they see the principle as an early warning mechanism that indicates an area of possible future consumer concern. A number of individual interviewees (not public interest or pesticide industry) gave equivocal responses. They were supportive of the principle but it was used politically (by NGOs), or that it was too impractical to implement. There was a complete range of views among the experts (members of the Advisory Committee on Pesticides). Some were hostile, some were supportive, and the rest equivocal.

Table 8.1 Stakeholder comments on the precautionary principle

1. Pesticide production[1]
• It is more important to manage the risk of pesticides rather than having a 'stop-the-world type of view' that is exemplified by the principle. • Precautionary principle has already been taken up in pesticides regulation • There is a problem because stakeholders regard the principle in different ways
2. Research
• It is too easy to take the principle too far **(IPM Researcher)** • It is difficult to use in practice **(IPM Researcher)** • Lack of information about a pesticide does not necessarily mean there is a problem **(Horticultural researcher)**
3. Control[2]
• A former DEFRA minister was supportive, but it was rarely mentioned by officials • The principle allows for possible problems to be flagged • There is a role, but the principle is not used in a systematic way • The principle does not answer the question 'how precautionary'? • It is easier for stakeholders to handle than for regulators • The principle is subjective and means different things to different people • We already have a very precautionary system • We have been applying the principle for the last 6/8 years
4. Experts[3]
• The principle is an acknowledgement of uncertainty, which is difficult to communicate • It tells us to be extremely concerned – because of uncertainty we must reduce risks • Precaution means positive evidence is required that adverse effects will not occur • NGOs use the principle because it suits them politically – it is not science-based • There is a place for the principle, but at what point are triggers used?
5. Food producers
• Definitely need a precautionary approach **(Supplier)** • Supports the principle – risk must be balanced against the need **(Organic farmer)** • The principle goes too far – it ignores the science **(Farmer)** • How to apply the principle given that the science [supporting pesticides] is fluid **(Famer)**
6. Food recall and manufacturers
• The principle is a warning – if there is a problem, withdraw the product **(Retailer)** • If there is credible evidence that supports the risk, apply the principle **(Retailer)** • The principle is fine, so long as everybody understands the rules **(Food Manufacturer)**
7. Public interest
• Very supportive because of cocktail effect; impact on vulnerable groups; endocrine disruption – its relevance is for new issues **(NGO)** • Supports a much stronger approach where debate is about scientific uncertainty **(NGO)** • Supportive when risks are for the consumer and the benefit for industry **(Media)** • Wants to go further – there should prevention principle where all evidence required is known and there is a need to act to prevent impact **(Independent campaigner)**

1. Responses from the pesticide industry; 2. Regulatory views, except 1st point; 3. All members of ACP

One conventional farmer interviewee maintained that the principle can be used as a way of stopping any technology. In that sense, it therefore poses a fundamental threat to the current pesticide policy paradigm:

"Yes you have always got to have the precautionary principle but the precautionary principle can be run away with completely. Well it is an old argument that if we always apply the precautionary principle we wouldn't have actually invented the wheel because every technology has uncertainty in it, has risks and it has downsides and it has problems associated with it. And society as a whole, really has to, however expressed, has to take a view on any new technology when it comes along and balance risks and benefits. The precautionary principle can be used very easily by a journalist or an interviewer to knock holes in any kind of position, particularly a scientist because a scientist is always aware that you cannot say that anything is 100% true and the journalist knows that and therefore you've only got to ask the question and the scientist gives whatever answer that the journalist wants and the journalist can then say well on the precautionary principle, etc." **Farmer, 18**

A similar view was presented from the pesticide industry which in effect represents a defence of the current pesticide policy paradigm. There is no scope for risk mitigation:

"It depends on what the definition of the precautionary principle becomes because if the end result is that nothing would happen, then that would be the result of taking it to its logical extension, because in my view it is more about trying to manage the hazard, properties of the products, trying to manage it. So I struggle a bit with the sort of almost 'stop the world' kind of view on these issues. I would hope that the regulatory process is sufficient to ensure that such an extreme position is not necessary – that is what I would hope and then it is all about, well how good is the science, that is what you are saying isn't it. Is the science enough?" **Pesticide Industry 41**

Both the above views show that a threat to the current pesticide policy paradigm, as presented by the precautionary principle, cannot be countenanced.

The following section reviews the precautionary principle. There is concern over 'false positives' and a belief that the principle stifles discovery and innovation (Holm and Harris, 1999, Anon, 2000). A false positive regulatory decision is one in which a pesticide has been banned or restricted on the basis of limited data, but subsequent data suggests the chemical to be relatively benign. The purpose of the principle, on the other hand, is to prevent 'false

negatives', that is failure to act to ban or restrict a product on a limited amount of scientific data, but when subsequent data proved a greater hazard did in fact exist. This is argued by Tickner et al. (2003), who maintain the precautionary principle can be used to prevent damage to health and the environment, whilst still providing economic stability. In this respect they conclude that society as a whole has not yet realised the full potential for science-based policy that the principle offers. As an example to follow, they cite Swedish environmental quality objectives that illustrate how precaution can serve as a compass directing society towards practices that are more ecologically sound, health promoting, and sustainable.

The NGO support for the use of the precautionary principle for pesticides has been backed up in practice to a limited extent. One particular example involved the implementation of the EU Drinking Water Directive in 1980 (European Commission, 1980) as revised in 1998 (European Commission, 1998b). The level of pesticide residues in Drinking Water was set at 0.5 microgrammes per litre (μ/g/l) for all pesticides and 0.1μ/g/l for individual pesticides. At the time this was effectively a surrogate zero for pesticide residues. The pesticide industry was lobbying for separate standards for individual pesticide active ingredients, based on toxicity tests. The European Commission however adopted the precautionary principle in the absence of sufficient data to back such specific standards (Kallis and Nijkamp, 2000). It was far lower than acceptable levels for pesticide residues in food. This could be achieved for drinking water because there was a technical option (carbon-activated filtration) available, although at a high cost. A similar end-of-pipe fix was not available for food. This meant that a precautionary approach could be taken for drinking water without threatening the current pesticide policy paradigm as a whole. It could also be argued that the precautionary principle is being applied by the European Commission with regard to some individual pesticides and data gaps.

Another area where the paradigm is not threatened is when a few active ingredients are banned, especially if there are suitable alternatives. An example where the European Commission took a precautionary view and the NGOs took a prevention view involved the banning of the organochlorine insecticide, lindane. It was banned across the EU during 2000 because the pesticide companies supporting its continued use did not provide enough environmental fate data. According to the minutes of an Advisory Committee on Pesticides meeting: "Approvals had been revoked following the environmental review of lindane, for failure to supply adequate data or reasoned causes to address all the core environmental data requirements" (ACP, 2001b). This was despite the fact that there were concerns that lindane is a possible human carcinogen, according to the International Agency for the Research on

Cancer and the US Environmental Protection Agency (PAN UK, 2005). Taking regulatory action against lindane because safety data gaps were not addressed does represent a precautionary approach, but it is done in a way which does not threaten the pesticide policy paradigm.

In other instances, precautionary approaches have been recommended by researchers studying the adverse effects of pesticides, although it may not always be described in such explicit terms. For example, maternal exposure to pesticides has been implicated in the development of childhood cancer, therefore the researchers raised the policy question of whether pregnant women should use pesticides at all (Rudant et al., 2007). In other cases, the precautionary principle has been linked to research conclusions. Davis et al. (1998) called for 'prudent precautionary principles' because of concerns about breast cancer and environmental contamination. They suggested that reducing exposure to avoidable or modifiable risk factors should receive high priority from the public and private sectors (Davis et al., 1998). Reporting on the impacts of brodifacoum (a rodenticide) on non-target wildlife, Hoare and Hare (2006) acknowledge the gaps in knowledge and call for a precautionary approach in a reduction in the use of the rodenticide. When assessing the occupational and environmental health risks associated with organophosphate sheep dip (diazinon), Watterson (1999) called for the application of a rigorous precautionary principle in both initial registration and the monitoring of chemical use. Sharpe and Irvine (2004) reported on several studies that have shown associations between prenatal or postnatal exposure to certain pesticides and phthalates (chemicals used to make plastics more flexible) and reproductive disorders in humans. As a result of these concerns, they recommended that alternative precautionary strategies must be adopted, seeking to eliminate or minimise unnecessary risks to the foetus, even in the absence of clear proof of harm. But those policy changes proposed have not been made by the UK government.

In addition, health-based charities such as the Canadian Cancer Society have supported the precautionary principle (Anon, 2007a). Many other environmental charities have called for the adoption of the precautionary principle when regulating for the use of pesticides including the Pesticide Action Network, Friends of the Earth, and the European Environmental Bureau. All of these recommendations come from those with a health/environment view, who do not directly support the pesticide policy paradigm, and have no resource dependency around the approval of pesticides.

Public interest interviewee support for the precautionary principle relates to the fact that it accommodates openness, stakeholder engagement, the consideration of alternative

technologies, and the role of science and uncertainty. One public interest interviewee explained in more detail:

There are so many uncertainties and that is one of the problems that we always have in persuading the government that there is a need to act is that the scientists advising government will always say that you can't prove that there is any link between ill-health and pesticide use. But there are so many gaps and uncertainties that, things like the cocktail effect and there is so much we don't know about the interaction of chemicals. There is a lot we don't know about exposure at low levels, the impacts on different age groups, and babies or the elderly for example. There is so much we don't know in terms of in particular health effects that we can't go and present absolute proof that exposure to pesticide A or even to pesticides ABCD etc together is resulting in a particular health effect. But a common sense approach is that we know that these chemicals are designed to kill, we know from impacts on wildlife that there are endocrine disrupting effects. So there must be warning bells going that it is quite likely that there is a potential health effect here and therefore it makes sense to cut down our exposure to those chemicals as much as possible. And given that it is not impossible, all it needs is the right political will and the right investment in alternatives. It just makes much more sense to go down the route of making sure that the way we farm is as safe as it possibly can be. **NGO 34**

Public interest NGOs were mostly supportive of the Precautionary Principle. The additional idea of the Prevention Principle was also raised by one interviewee:

"I would actually go further than that and say not just the precautionary principle because the precautionary principle is based on the fact that you have to have precaution because there is not enough, or sufficient scientific evidence for action to be taken. I would actually say there should be a Prevention Principle which is used in areas within the US. And actually I think it was a term either coined by, or at least has been supported by Samuel Epstein in America, a cancer specialist or one of the leading cancer experts in the world, and yes, the Prevention Principle is when you have got the evidence, it's all there, and you need to act to prevent the impact from occurring, and therefore I call for a Prevention and a Precautionary approach, but more of a prevention approach." **Independent Campaigner, 47**

Here there is certainty that prevention is required. In this case there is no room for debate, and no support for the pesticide policy paradigm. From this point of view there is sufficient

scientific data in the public domain about exposure to pesticides and ill health to warrant prevention.

Others Stakeholders are more equivocal. One member of the ACP agreed that there is a place for the precautionary principle, but how it is triggered?

"There must be a place for the precautionary principle, but it is at what level, isn't it. The risk assessment as it stands in effect is a precautionary principle, the way it is operated but, if you took it to the nth degree, nothing would ever be registered because there is always an uncertainty... you are never going to get away from that uncertainty because science is not perfect and the knowledge isn't always there, but over time, if you go back over 30 years, we were approving pesticides that at the time appeared to be OK. Now we know better, and the situation has improved, and risk assessments are constantly being updated and reviewed and refined. So, over time, the situation improves and I would hope that that would continue. So, yes there is a place, but it has got to be kept in balance for the needs of the industry and the concerns about the environment, the consumers, the operators etc. So it is all about balance." **ACP 13**

One UK regulatory view was that there is already enough scope for 'precaution' within the existing regulatory system.

"I think it [pesticide regulation} is a very precautionary system and... We are cautious and if in doubt we fall back on our right to ask for more information." **Regulator 22**

This perhaps explains why one former minister recalled that the precautionary principle was not discussed much in terms of policy development – because the regulatory view was that the status quo was sufficient. The minister felt the use of the principle was "almost entirely absent". He continued:

"The precautionary principle was rarely talked about. I would talk about it. I don't remember my officials talking about it because of course precaution would mean that one would be much more cautious." **Former DEFRA Minister 19**

8.2.2. Uncertainty and the Precautionary Principle

This section deals with interviewee feedback on uncertainty, an element of the Precautionary Principle, within the regulatory risk assessment process for pesticides. The uncertainties surrounding the scientific analysis can have double-edged political connotations. They can be used to engender caution (from the NGO), or they can be used to indicate that actual ill health has not been proven and therefore it is still acceptable to use, especially if there is a food supply chain need for continued use.

The pesticide risk analysis process poses a number of uncertainties. These include estimates of exposure and the interpretation of scientific safety data presented as part of the regulatory process. A number of interviewees discussed this issue, especially in relation to the interpretation of scientific data. The risk analysis process is heavily reliant on the extrapolation of animal toxicology data (usually on rodents) in order to estimate the intrinsic hazard for humans. The risk is then estimated as a product of the estimated hazard and the estimated exposure to the hazard. The hazard assessment and characterisation is always subject to interpretation. Toxicology data from the animal studies is subject to variation because of interspecies differences between the test animal and humans. There is also an extrapolation from high dose (in experimental animals) to lower dose intakes (of humans). There are also likely to be inter-individual differences which are predicated on the sex, age and genetic susceptibility (Renwick et al., 2003, WHO, 1999b). Uncertainties that are inherent are said to be taken into account by the use of conservative assumptions and approaches, or uncertainty factors (Renwick et al., 2003). Uncertainty factors have been used since the 1950s to establish acceptable intake thresholds for toxicants, (including pesticides). This is usually (but not always) a factor of 100 fold (10 fold factor for inter-species differences, and another factor of 10 for human variable). An additional 10 fold factor could be considered appropriate in certain circumstances for infants and children if testing methods were considered inadequate or if the nature of the hazard was irreversible (Renwick et al., 2000). It is against this backdrop that interviewees discussed how to deal with toxicological uncertainty. In the UK, the members of the Advisory Committee on Pesticides have to take a view on these issues of uncertainty as part of the advice they give to DEFRA ministers concerning pesticide safety. One ACP member agreed that there are difficulties in expressing uncertainty, in terms of the Committee of Toxicity, which liaises with the ACP on relevant matters:

"...the Committee of Toxicity has got a working group on variability and uncertainty and toxicology, and one of the issues that has arisen, and I think will probably emerge more

strongly in the final version, is 'how do you express uncertainty' because I think we are not very good at expressing explicitly the uncertainty, and one of the ways of doing it is a sensitivity analysis." **ACP member 36**

Normally uncertainty factors of 10 times for intra species variation and 10 times for inter species variation are applied to the safety calculations. The issue of adding extra uncertainty factors has occasionally come up at ACP meetings. But what the uncertainty factors means in general terms is that the scientific analysis will never be able to prove absolute safety or be absolutely accurate. Another member of the ACP also expressed the difficulties in accommodating uncertainty in the pesticide risk analysis process. This is not widely acknowledged, and as a result, one member of the ACP said that there should be a more precautionary approach to risk assessment:

"The first step is the acknowledgement of uncertainty and what do you do with that uncertainty? And different people will have a different view on firstly the level of uncertainty and the significance of uncertainty... It [risk assessment] doesn't consider mixtures, it has a certain approach to uncertainty and applies arbitrary uncertainty factors. But that doesn't necessarily account for some of the long term effects or the differential effects of different stages of life. Or indeed the interactions within the wider environment. Protocols that are robust and well stated are not necessarily comprehensive enough to give any sort of assurance and of absence of risk and it is acknowledged that nothing is risk free. But it is not transparently acknowledged that there is still residual uncertainty that should encourage a greater degree of caution in my view.." **ACP member 03**

Other stakeholders have concerns about uncertainty within the risk analysis process. A multiple food retailer interviewee was content with the data that is produced to make sure the pesticide product performs effectively as a pest control agent, but was concerned that the unintentional effects of pesticides are less well understood:

"... in the 30 years that I have been looking at pesticides approvals, that the data submission generation has changed dramatically, and is much more robust than it was. The models used have changed. But there is still way to go because how can you fully model what the impact of a pesticide is on all the things that it touches. And that's the bit I have great difficulty with. I can understand the current thinking about regulation in terms of the residue levels that are not sufficient to cause health problems according to the PSD type models. But a lot of the data that has been derived so far is actually on efficacy and

good agricultural practice, not particularly on the impact of the pesticide and its knock on effects in biodiversity models or in the cocktail effects of pesticide residues – are the things that bother me." **Multiple Food Retailer 37**

A former minister also made the distinction between the greater knowledge for individual new pesticides compared with mixtures of pesticides:

"The system for registration through the Pesticide Safety Directorate process for new pesticides is pretty rigorous. There are aspects of the 'cocktail effect' which I do not think is properly understood... and the back reassessment that is now being done with the British PSD and under the EU process will exhume a lot of potentially harmful pesticides."
Former DEFRA minister 45

Many of the public interest NGOs were also concerned about uncertainty, and expressed this in terms of the 'cocktail effect' of exposure to multiple pesticide residues, and the indirect effects of pesticides. In 2002 there was pesticide stakeholder input to UK Committee on Toxicity review of the risk assessment of mixtures of pesticides (Committee on Toxicity, 2002). The report agreed that there are accounts of adverse effects to multiple residues under laboratory conditions, but not for human exposure. And that foetuses, infants and children might be more sensitive to endocrine disruption and neurological effects of pesticides. It reported further uncertainty by concluding that the extent to which genetic differences between individuals affects susceptibility to mixtures of pesticides is not known.

There are a number of new issues that have added to the areas of uncertainty for pesticide risk analysis. Combination toxicity addresses the impacts of one or more pesticide active ingredients, and other non-pesticide chemical components of the formulation, and other chemical contaminants. Currently pesticide regulation is largely based on assessing chemicals individually, rather than their collective impact with chemicals. Synergistic effects (linked to combination toxicity) can produce unexpected dose toxicity-response. Curves which are difficult to explain: Does the dose make the poison? This is very contentious, and could work both ways (in terms of those supporting/not supporting pesticide use). Scientific disagreement/uncertainty is increasing within independent government independent committees such as the Advisory Committee on Pesticides. These incremental problems associated with pesticides were handled reactively rather than in a precautionary manner. Often industry was in denial of the problems and government has had to act belatedly to catch up. This step-by-step process has had a cautionary effect on an apprehensive public who have become increasingly wary concerning the use of pesticides.

An NGO interviewee further acknowledged the concern about the limitation of risk analysis. The risk analysis process is too inflexible to respond to new evidence about the adverse effects of pesticides and the changing views on the levels of risk:

"...it is absolutely hopeless at identifying problems that they we don't yet understand or are only dimly aware of. **NGO 10**

A conservation NGO accepted that the regulatory process for pesticide was robust in term of what it tests, but there are areas of concern that are not included:

"The robustness of the approvals process (I don't know everything about the approvals process, but from what I do know) is that it tests what it tests quite closely but it doesn't include a lot of things – it doesn't include the indirect effects... and it doesn't look at cocktail effects of chemicals – what might happen in tank mixes, it doesn't look at additives such as surfactants to make them [the pesticide formulation] to work better... Those [effects] could be having damaging effects on biodiversity... it's not a full process as far as we are concerned." **NGO 11**

One member of the Advisory Committee on Pesticides with horticultural experience felt it was difficult to see how the regulatory process for pesticides could be improved, because absolute safety cannot be proved and uncertainty always evident:

"It is difficult to see where it [the regulatory system] can be improved drastically because I think that clearly there are still gaps in the science and understanding of particularly low dose pesticides, and that brings in the aspect of uncertainty. And whilst it is reasonable to assume, based on the data that is collected, that these products are safe, you can never say they are totally safe because there is always that small level of uncertainty." **ACP 13**

Uncertainty over how to interpret the science and lack of direct human data are at the heart of how the precautionary principle operates. When should uncertainty trigger a regulatory response? The precautionary principle also allows for a hazard based approach to pesticide regulation compared with a risk assessment approach. A member of the ACP made the argument for a hazard based approach because it takes much of the uncertainty out of the risk analysis.

But I think one should be transparently communicating uncertainty and that is a clear requirement in giving advice to government. And I think the ACP as a science advisory body has failed in that. And indeed the chair of the ACP said it was impossible for it to do that job properly because it was just too busy there were too many things to do. So on the basis of uncertainty, precaution should be necessary which would lead to a different approach to delivering pest management solutions, and engaging with society generally to enable them to make choices based on the use of pesticides. So the role of the precautionary principle should be to lead to successive reduction in pesticide use and the progressive deployment of lower risk substances which have a lesser degree of uncertainty attached to them during the risk assessment process. So that for example, a hazard based approach leads to a more precautionary approach because you step on one side from a complex risk assessment process and say these substances are intrinsically more hazardous and therefore we shouldn't be using them. **ACP member 03**

Another member of the ACP accepted that there should be a role for the precautionary principle in pesticide risk analysis and regulation, but accepts that it is difficult to establish at what point the trigger should come into force:

"There must be a place for the precautionary principle, but it is at what level isn't it. The risk assessment is as it stands a precautionary principle, the way it is operated. But if you took it the nth degree, nothing would ever be registered because there is always uncertainty... If you go back 30 years we were approving pesticides that at the time appeared OK, Now we know better, and the situation has improved, and risk assessments are constantly being updated and review and refined... It is quite difficult to know exactly where the trigger [to invoke the precautionary principle] should lie and that is going to vary from chemical to chemical, or biological [control agent]." **ACP 13**

In conclusion, the precautionary principle is widely recognised as a legitimate approach but there are concerns, especially from some sectors of the food supply chain. Critical stakeholders see it as a way of reducing the risks associated with pesticide use. As far as the pesticide policy network is concerned, there are areas where there is no common ground. But it does nevertheless provide a framework around which openness, transparency, stakeholder engagement, consideration of alternative technologies, and the role of science in policy can be discussed and developed.

8.2.3. The interface between science and policy

In approving pesticides in the UK and EU, regulators carry out a risk analysis that includes a risk assessment which is overseen by a risk management process (see also Figures 2.1 and 2.4). Risk assessment represents the technical element of the pesticide approval process, and the risk management then incorporates political aspects of the process.

The question of whether risk assessment is separated from risk management is important because it informs the debate as to whether these two processes distinguish between science and policy. In practice it is very difficult to put what van Zwanenberg and Millstone (2005) describe as a 'firewall' between science and policy. Protecting the sanctity of science as an objective clear of human application is impossible.

Once an active ingredient has been approved, products that contain it are assessed by the Member State for specified uses. In responding to an application, the UK government would be expected to draw on the scientific assessment that has already been agreed at the EU level. New active ingredients are increasingly being approved under the EU system, and work has begun to review many of the older pesticides that are on the markets of individual Member States. It will be some years before the process is complete and in the meantime the national and EU systems will continue to work in parallel. The research was particularly interested in comments on the risk assessment/risk management process; the level of openness and transparency; aspirational changes that the interviewee may or may not have; the role of science and policy; and the role of stakeholders in the process.

A member of the ACP commented that the judgement about serious or acceptable risk should be political:

"...there is no coherent explanation of what is a serious or acceptable risk, so the wording that is used, there is no acceptable risk to health – but who decides what is acceptable... ultimately you could say it is a political decision in a democratic society, which means the advisory committee should be much more open about quantifying the possible, or ranges of risk." **ACP member 03**

An interviewee from the pesticide industry, however, pointed out the predominance of science in considering pesticides as acceptable in the regulatory approval process:

"...we are a highly regulated research-based/ industry, and once you start moving away from the science, then that causes us no end of problems, because everything is totally unpredictable and you just don't know where things are going to go next. So the science is absolutely king as far as we are concerned. But you have to address the social issues too." **Pesticide industry, 40**

There was a difference of emphasis between the regulators and the pesticide industry on this issue:

"...Some very good people trained me up, and they said that ultimately the decision is always political. Industry have always turned round and said no, no, no, no. It has always been based on good science. That's rubbish. The decision is always political. Now, that politician can accept the science and leave it at that." **Regulatory affairs, 39**

"...the regulators which are in an uncomfortable position, that on one side they should take their decisions purely on the basis of law and science; but on the other hand cannot deny that they live in a political environment." **EU Regulator, 46**

The regulatory view also acknowledged that the science process during the risk assessment is important, but it concluded that pesticide decisions always end up as political. This difference was not specifically acknowledged by either pesticide industry or regulatory interviewee, nor was it expressed by anybody else. The present research argues that there is a difference in interpretation of the risk analysis process. The pesticide industry view the 'science' as paramount, whereas the regulator sees pesticide regulation as a 'science-informed' but that in the final analysis the decision to approve a pesticide is a political not scientific decision:

8.2.4. Findings from the UK model on the integration between risk assessment and risk management

The UK risk analysis process for pesticides has traditionally been represented as following the technocratic model as outlined in Chapter Two (see Section 2.2.2). Data from the interviewees included discussion of accommodating uncertainty in the risk analysis process. There was a limited range of views as to how to characterise risk assessment and risk management, and whether their functions should be separated or integrated. Linked to this is the interface between the approval of pesticides and oversight of pesticide policy. The distinctions between science and policy, as introduced in the previous section, are also relevant in this section on the UK and the following section on the EU.

There are three elements to pesticide regulation and approval in the UK. Technically DEFRA ministers 'sign off individual pesticide approvals'. Ministers can intervene but in practice rarely do. They are reliant on recommendations from the scientific expertise within the Advisory Committee on Pesticides. The ACP in turn is highly reliant on the regulatory body, the Pesticides Safety Directorate (PSD). As noted in Chapter Two (see section 2.2.2) the ACP considers itself to be a late-stage risk assessor and risk manager. There is a lot of interdependence on data from the PSD to ACP. The ACP is undoubtedly independent of PSD, although some members inevitably receive funding from public sources, and it is heavily dependent on PSD for presenting the data that the pesticide industry has generated.

In the UK risk analysis is integrated and it is difficult to make a distinction between risk assessment and risk management. This is important because it can reduce possible conflicts of interest. The opportunity for a separation between the two presented itself in the UK when the Food Standards Agency was created in 2000. Professor James recommended it in his FSA outline report (James, 1997).

Results from the interviews show that there are different views about separating or integrating risk assessment from risk management. There is the theoretical desire for separating the two roles, as well as an awareness of the practical difficulties that this throws up. This is a reflection of the difficulty surrounding the issue. There is a view that risk assessment (science) should be separated from risk management (politics) but also an admission that there may be some political slippage by allowing economic need into the risk assessment process. An IPM academic considered that it was important to separate the two:

> *"It is possible to engage experts to look at the science based on which policies are made, but it is probably inappropriate to recruit scientific experts to look at policies per se. I think it is really important to separate those two."* **IPM expert 09**

A number of other interviewee sub-groups maintained there is a need to distinguish between science and politics, especially at the risk assessment stage. A farming interviewee said that the first point is to obtain the best scientific assessment, and then one can act on it. It is important that the former process is as free of politics as possible – which is almost impossible, he conceded. An NGO interviewee also considered that it would be wrong to assume there are no political interests within the risk assessment process. Furthermore, the present research can support the fact that farmers' needs have been raised at an ACP

meeting[60]. This is further emphasised by the fact that members of the ACP have a wide range of declared interests with the UK government, pesticide industry, food retailers, and public interest NGOs[61]. One member of the ACP commented that policy discussions occur on a regular basis at committee meetings which means that members do not restrict themselves to technical risk assessment issues:

"In general terms, there are a lot of issues that come to the ACP, in policy terms, which are discussed at length and you have the opportunity to present a view. Sometimes I present a view if I think it is relevant, otherwise I don't, depending on how close it is to my area of expertise and knowledge." **ACP 13**

One member of the ACP explained how the risk assessment and risk management relate:

"The risk assessment is a scientific process which evaluates the data and captures the uncertainty and that is what is then outputted to the risk manager in a form that is useful to them and finding a way to express that risk assessment is one of the things we need to work out most effectively. The societal interface is reflected in several different aspects. One is that it reflects the level of prudence that is required in a risk assessment. So the risk manager then requires the risk assessor to set a particular level of safety that they want. Now we currently work on a default safety assessment factor of one hundred. But it could be that the risk manager says 'I want to be much, much more secure in my risk assessment', and so set a different level of safety." **ACP member 36**

This interviewee considered that in theory there should be a clear distinction between the two, but that it is difficult in practice. Certainly the risk assessor should not go on to make policy, he went on to conclude. Another member of the Advisory Committee on Pesticides was in favour of integrating the role of risk assessment and risk management. The ideal would be to separate the two, but the practical realities are different:

"[risk assessment and risk management]... are really different entities, the real question is should they be done by different groups of people? Well they are clearly different expertise. I am in the risk assessment business in a way in this context. The risk management side of it is in a way partly political with a large 'P' and partly of course you need to have the input from experts who are aware of how to handle that, with risk management expertise...My

60. The researcher was allowed to sit in on an ACP meeting during 2007, on a non-attributable confidential basis.
61. See for example, the ACP Annual Report for 2003 ACP (2004) Advisory Committee on Pesticides Annual Report 2003. London, DEFRA/HSE.

view is if you are really going to deal with this complex area, my feeling is that there needs to be an integrated approach to it. If you separate them too definitively there is a risk of not having time to sort things out because you just have documents going backwards and forwards between one building and another, whereas here you have got the opportunity of a more integrated approach ... There has to be a balance between what a utopian ideal and the practicality of making a system work for the good of the public health. I don't think that there is...I can see why people do think that there is a conflict... I personally don't think there is a case because I think there are benefits to be gained from having that integration." **ACP 44**

The issue has arisen that the Pesticide Safety Directorate should separate its regulation and overview of pesticide risk analysis from pesticide policy. As regulator it is responsible for approving and monitoring the use of new and existing pesticides. An example of PSD's policy network resource dependency can be seen in the fact that it has to generate part of its income as approval fees for the risk analysis of new pesticides from the applicant pesticide companies. There is nothing wrong with industry paying to register its products, but when the same agency is responsible for overseeing reduction in the risks posed by pesticides, questions are raised about a possible conflict of interest:

"...with the experience of BSE, the ministers are very comfortable if some of these difficult decisions were removed from the political arena, maybe because there has not been a BSE on pesticides, they haven't faced the pressure that would fundamentally change the system. So there may be element of well if it isn't broke, don't fix it. There are all sorts of models and none of which are perfect. Although my own take on it, and probably the general view you would hear within PSD, would be that actually PSD works pretty well, because it is integrated, and you know, it is a little bit independent, but still bound in, because on the policy side there is real value to be bound in with the ministry, with the department because in the usage area, things like the CAP reform, and the way that agricultural subsidy policy is moving, and things like the Water Framework Directive will potentially have a big impact. And so it is important to be tuned in with those policies." **PSD Regulator, 23**

Risk communication is a process normally carried out by regulatory risk managers. The task is to communicate to a wider audience the conclusions of the risk management process in a way that is easy to understand. It should also help to foster trust in the safety of whatever process is being analysed for risk (Van Eck, 2004). Risk communication is considered to be

problematic (Brimer, 2004). This ACP interviewee agreed, calling it a huge problem, and in addition called for the need for a range of different professionals to be involved:

I really think that we haven't got that sorted yet, and there needs to be psychologists, sociologists other experts, media people thinking about how can we communicate this information effectively, clearly. But also, within limitations, accurately, and I say 'within limitations' because I went to a media communications presentation a few weeks ago and they were saying you have got to present your message clearly and unequivocally. And I said 'as a scientist I can't be unequivocal, we are taught to be equivocal all our lives!' And they said 'they don't want that, they want to be given a clear message, and I said that that is the dichotomy we live in. **ACP member 36**

8.2.5. Findings from the EU model on the integration between risk assessment and risk management

Most of the interviewees were less familiar with the complicated and ever-changing EU regulatory process. The EU risk analysis process has separate risk assessment from risk management. With the creation of the European Food Standards Agency (EFSA), it carries out risk assessments for pesticides (among many other food safety issues); and The European Commission corrals risk management between DG SANCO and the EU Member Sates. This is not an easy issue to resolve because there are conflicted forces at work. On the one hand there is a potential conflict of interest if risk assessment and risk management are carried out in the same organisation. There may be policy directives, such as an overall aim to reduce pesticide use which may conflict with a regulatory role that is set up to approve pesticides, and receive registration fees from companies that want to market pesticides.

The extent to which the decision to approve a pesticide is political or scientific can vary. If a decision is not less contested, it will be a 'scientific decision'. If there is an economic issue, or it is border-line it can mean the decision becomes political. So the more difficult the decision, the more likely it is to be political. One example of this was the decision to review and approve eight pesticide active ingredients the EU process. Normally Member States vote on the approval of an active ingredient through the European Commission Working Group (legislation) of the Standing Committee on the Food Chain and Animal Health (see Figure 2.4). But, because Member State voting was so equivocal and contrary, it was decided that the regulatory approval decision for the eight active ingredients was passed up to EU Commissioners (Anon, 2006). This is reinforced by a public interest interviewee who linked uncertainty with recourse to political decision-making:

"Often those real decisions come down to political decisions, especially in the face of scientific uncertainty." **NGO 10**

This is also recognition of the political pressure facing the regulators from all sides. There are large regulatory departments within the research and development pesticide companies, but the number of companies is declining, and compared to other industrial sectors, as an industry interviewee noted, the pesticide business is fairly small by global standards. One NGO interviewee considered that they were out-numbered in lobbying terms compared with the pesticide industry, but the NGO sector is nevertheless organised – albeit it on a smaller scale. As a group they are technically qualified, or can draw on such expertise, and have developed experience of pesticide policy matters. This strength is reflected in a regulatory response:

"...there are two stakeholders which are for my perception the most successful. That's the big industry companies so in that respect European Crop Protection Agency. And the second one is the environmental non-governmental organisations (NGOs). And I think in particular Pesticide Action Network and Greenpeace. So, their impact is very different, because ECPA is more managing to have an influence via directly influencing the discussion process very actively, influencing also the drafting process by providing some expertise; whereas the environmental NGOs just take the opposite way by not participating in the drafting of the process but by creating a very high political pressure at the end... I am often surprised about the weak lobby of the farmers at European level... which is probably due to the fact that agriculture in Europe is so different, that it is very difficult for them to find a common position". **Regulator, 46**

Although the tactics of the pesticide industry and the NGOs are perceived by the regulator to be quite different, they are well adapted to networking at a European level, where pesticide legislation is now being drafted. The farming lobby on the other hand struggles at a pesticide policy technical level where they have otherwise been seen to have benefited from a lingering Common Agricultural Policy supportive of farming production.

There have been suggestions for more public interest involvement in the risk analysis process, as outlined by 'citizen science' (Irwin, 1995). This does present problems with a NGO involvement in the risk analysis process. As one NGO interviewee explained they are going to do the regulators job for them:

"... As an organisation we advocate for more participation of public interest groups at appropriate stages in regulatory decision making. We are not there to do their job for them, but there are stages where we should be consulted more. I think one of the problems is the way that information on complex issues can get presented in the regulatory process. How can you actually engage non-experts in that process? I think you need some expert independent facilitators in that process – people who are employed specifically to try and explain what the issues are in terms that everyone can understand. Often those real decisions come down to political decisions especially in the face of scientific uncertainty. Which way do you go? Businesses as usual until problems mount up, or do you take a more precautionary approach? There is nothing particularly technically complicated about those kind of decisions. But they are often presented as technical decisions. How you vouch for getting someone who can be totally independent to facilitate those kinds of processes, I am not sure; but there are a lot of people who understand the technicalities of the issue who have often worked inside the industry at some stage. **NGO 10**

A summary of interviewee responses on whether to separate risk assessment from risk management is presented in Table 8.2. These comments are taken from a review of all the interviewee data on this particular topic.

Table 8.2 Stakeholder views on the separation of risk assessment and risk management

1. Pesticide production
• Integrated risk management and risk assessment will only work if there is very good communication between the two separated agencies **(Pesticide industry)**
2. Research
• It is important to separate the science experts [risk assessment] from policy [risk management] **(IPM Expert)**
3. Control
• There are many conflicting issues between risk assessment and risk management at the EU level **(EU regulator)**
4. Experts[3]
• Risk management is ultimately a political not a scientific decision **(Regulator)** • An integrated approach is needed **(Regulator)** • Need to balance risk versus need **(Regulator)** • Former DEFRA Minister was in favour of integrating risk assessment with risk management
5. Food producers
• Need to act on the best scientific advice, and try to make the process as free of politics as possible, that is, for the separation of risk assessment from risk management **(Farmer)**
6. Food recall and manufacturers
• Not content that risk assessment and risk management are carried out in the department **(Retailer)**
7. Public interest
• The general public has little idea about pesticide risk assessment **(NGO)**

8.2.6. Summary: key findings

The precautionary principle is widely recognised as relevant and important, but the practical implementations are challenged. It allows for a more precautionary approach to risk analysis and as such it appeals to public interest NGOs, and health and environmental professionals. Those within the pesticide community are generally against it because it threatens the pesticide policy paradigm. There is little common ground because the defence of the paradigm is paramount. Those supporting the paradigm criticise the precautionary principle by saying it is 'unscientific', but it is designed to accommodate that which current scientific knowledge cannot yet accommodate. There are uncertainties within the risk assessment process that are unquantifiable, and therefore the decision comes down to sound judgement. It has to prevail and a decision has to be made as to whether that uncertainty is acceptable, given the economic, social and political need for a particular pesticide. There are a number of ad hoc examples, of precaution within the regulatory process. But the implications of applying the precautionary principle for pesticides across the board are more problematic for those defending the pesticide policy paradigm. Here the process is seen as a mechanism for significant reduction in pesticide use, openness to criticisms from outside, and increasingly within, the food supply chain of the pesticide regulatory process, and an examination of alternative products and systems for pest and disease management.

The difficulty in dealing with uncertainty is acknowledged by members of the ACP. There are different views on what is meant by uncertainty, and propositions that it does not capture all the uncertainty that we know about, such as combination effects of multiple exposure and interactions within the wider environment. Uncertainty thrown up by science can also have double-sided connotations – it could pose an acceptable or unacceptable risk. It also acknowledges the limitations of 'regulatory science'. As one ACP member indicated his academic training had always been encouraging of equivocal scientific endeavour which is completely at odds with the regulatory requirements of presenting a message clearly and unequivocally.

Risk communication is acknowledged as a big challenge – communicating a complicated technical issue in simple terms to the general public. There is a recommendation for a whole range of (non-pesticide expert) professional assistance. The problem with this strategy is that the consumer 'dissenters' and critical stakeholders within the pesticide policy network are growing and having their impact on the food supply chain. Their concern is not about being

re-assured about the uncertainties within the risk analysis process; it is about acknowledging that these uncertainties are unacceptable per se, and alternatives need to be considered.

Discussions involving the precautionary principle are said to be an opportunity for common ground to be established among different stakeholder groups. In the case of pesticides, for some stakeholders, there is no common ground. They see no need for pesticides, and there is no compromise or negotiation around that point. Nevertheless the principle is here to stay and it something that the pesticide policy network will have to make operational, or face the consequences of an irreversible threat to the pesticide policy paradigm.

The precautionary principle embraces the co-decisionist model of risk analysis, and there are concerns from the pesticide industry and some sections of the food supply chain. Their view, that science dominates, is more in line with a technocratic risk model. The regulatory view also acknowledges the scientific input, but puts greater emphasis on the political reality of the pesticide regulatory process. This difference adds to reduce the integrated cohesion within the regulatory paradigm element of the pesticide policy network. The ACP experts also acknowledge the intervention of risk management into the risk assessment process, no matter how much the desire is to separate the two. This suggests the UK is moving away from the traditional technocratic approach to risk analysis, but in a way that lacks transparency for the outside observers. For the EU, where risk assessment is separate and carried out in one organisation, and risk management in another, there is a concern that the risk management will lose touch with the risk assessment process. For re-connection, an integrated compromise has to take place. The risk assessment process is changing all the time, becoming more complex, and therefore difficult to assess and manage, adding extra pressure to the pesticide policy paradigm.

8.3. The pesticides debate: A range of perspectives from the pesticide policy paradigm network

The interview data revealed a number of issues which challenge the use of pesticides. Some of the interviewees questioned or doubted the need for pesticides from a fundamental point of view. The civil society interviewees in particular were keen to see a wider debate on the sustainability of agriculture. The traditional assumption that 'pesticides are vital' is also being challenged within elements of the food supply chain. For most of those within this supply chain, however, the dominant consideration was that the economics of conventional crop production is an overriding factor when considering the need for pesticides. The historical legacy of pesticides was raised by interviewees. With a few exceptions,

interviewees did not dwell heavily on the historical legacy of pesticides, although it was brought into answers on other subjects. For supporters of pesticides (farming) it was used to demonstrate that lessons had been learnt. For public interest groups history reminded them of what else might happen – a dread factor.

Interviewees' views clearly demonstrate that there are different views within the pesticide policy network. Opinion polls consistently show the general public has concerns about pesticides, especially in relation to residues in food. This societal concern is reflected in the resources and organisation developed around pesticide campaigns by public interest organisations. Multiple food retailers have, in some cases, taken account of the consumer concern and are trying to accommodate their views, rather than deny them.

Finally, this section acknowledges the difference between the economic productionist views of the pesticide policy paradigm, and the environmental health views of the critical stakeholders within the pesticide policy network.

8.3.1. Is there a need for pesticides?

The first observation from the interview data addresses two fundamental questions about pesticides: why do we use them and are they necessary? It corresponds to the first question (see Table 3.2). This has important implications for the pesticide policy paradigm, in terms of its defence and the pressures that are placed upon it. The view from pro-pesticide productive stakeholders is that pesticides are an important input without which needed food supply would be severely compromised. There is an assumption that pesticides are vital, and this frames all subsequent ideas about the need for their development, marketing, regulation and use. A conventional farming and pesticide industry view characterised the need as:

"... a capacity to create a range of products that people want to eat, buy and use at a price that people are prepared to pay in the First world, which allows for First world life styles and incomes to be lived by those people producing them." **Farmer, 32**

"I think it is about helping to produce the quality and expectations that food companies have in terms of food production. At the farmer level there will be specific benefits to the grower, they are under enormous pressure these days to deliver on price, it is quite a complicated economic model they are working to. There is a huge push-down on price, and crop protection products offer a very cost-effective solution to the problems they have." **Pesticide industry, 41**

These two views show that the economic and production parameters have an important hold on the food supply chain. Pesticides and other key inputs have been designed as part of conventional farming in addition to all the wider forms of agricultural policy such as education, research, agronomic advice, economic support, and regulation (Atkinson et al., 2003). Synthetic pesticide pest control has become the dominant pest management tool because it suits ways in which the conventional food supply chain works and integrates. It allows farmers, industry and policy-makers to work within a common framework with powerfully effective methods of pest control producing high yielding crops. They have become institutionalised within this group.

The dominant pesticide paradigm view was expressed by one or more interviewee in all the stakeholder sub-groups, except the public interest groups. What if the question is turned around, what are the implications for conventional farming if pesticides were not used? A farming interviewee explained how inter-locked pesticides are within the farming system:

> *"If we were not using pesticides on a national scale... you are not just looking at that one spray, that one field, you are looking more at a system-basis and to go to a non-pesticide situation in the whole country you are looking at the whole system. You would have to completely change the rotations, the way they farm, the number of people they employ, how they went about the whole thing, because you'd be looking at it right from when you started planting the crop. You would change the time when you planted the crop, what are the crops you grew in rotation, it is a huge education problem, a whole knowledge-transfer that would go with it as well".* **Farmer 18**

Such a fundamental change presents a number of risks and uncertainties for farmers. They would be centred around the development of crop prices, European policies, the behaviour of consumers, the farmer's ability to learn a new way of farming, and the need to change and develop new networks (de Buck et al., 2001). These perceived risks are a barrier to change, and help support the dominant pesticide status quo. The question whether pesticides are used is not routinely asked as part of the pesticide approval and regulation process. At the same time, neither are there any papers or reports that have given detailed consideration to a zero-pesticide use scenario for the UK. The typical regulatory view accepts the need for pesticides. Indeed the Pesticides Safety Directorate (PSD) cannot exist without pesticides to regulate and approve. A regulatory interviewee outside PSD had accepted and not questioned the need for pesticides, but there was also a realisation that he had not rigorously challenged this view:

"I am starting from a point of accepting, partly based on my understanding of practical agriculture, that there is a need, and will continue a need. But I have not challenged that rigorously myself in any academic sense, but have allowed others to do it, and have accepted the arguments that have come forward." **Regulatory, 43**

Another regulator with former responsibility for pesticide policy confirmed that they had carried out no serious view of the need for pesticides:

"I have never been involved in any serious work looking at analysing pesticide need, in a more holistic way. In other words, I have done a low of work on insect pests and crop protection requirements more generally. And I am happy about the justification for their use and part of a crop production system, and the relevance in controlling pests and diseases in those systems... So I am starting from the point of accepting, partly based on my understanding of practical agriculture, that there is a need... but I have not challenged that need myself in any academic sense, but I have allowed others to do it." **Regulator 42**

The same regulator made a further link between pesticides and agriculture in the UK:

"If you really, really unpick the question, you come back to the fundamental question: do you need agriculture at all in the UK?" **Regulator 42**

A further regulatory interviewee confirmed the historical the need for pesticides, but for today the situation is not so clear-cut:

"...pesticides clearly have helped agriculture go in a certain direction and at a certain pace. Now, whether we need to do that – to continue doing that, I don't know. I don't know the answer because I don't have the information. I can't find that information. Now everything is a global market." **Regulatory affairs, 39**

The implication here is that the UK can no longer make a decision to stop using pesticides on its own. The global food supply is predominantly based on conventional agriculture and pesticides are a dependent part of this process. World markets create pressures to produce cheap food and maintain pesticide use.

Some multiple food retailers have developed their own pesticide policies in recent years (see Vol. 1, page 236). Previously they relied on the supply chain and regulator to police such

issues as pesticide residues in food. Their more active role has led to a greater enforcer role within the pesticide policy network. Their policies are framed around reducing pesticide residues in food, even eliminating them altogether. They do not want to abandon the pesticide policy paradigm altogether, although one interviewee went as far as questioning the need for a chemical solution:

"...we don't need a chemical solution here, there is a more integrated natural way in terms of cropping, farm management, that does the same." **Multiple food retailers 08**

As suppliers of large volumes of food, they are aware of the commercial need for pesticides within a conventional farming system, but would rather see safer alternatives developed because of the concerns over pesticide residues in food. They want pesticide to produce quality products, but do not want the residues which have the potential to harm their business. In this sense they have traditionally seen pesticides as a necessary evil. Some are beginning to question the 'vital' element, but realise the ingredients for an alternative are not currently in place.

A number of critical stakeholders, such as those who support organic farming, maintain a fundamental view that there is no need for pesticides. Others, such as an academic working on alternative pest management and public interest NGOs, think there should a debate on the issue:

"I think what is required at the start is a change of attitude, almost that pesticide aren't essential and therefore we look at each pesticide as it comes up for approval as to whether we really need it or not, and whether there are better alternatives that are chemical alternatives, that is not done at the moment. It [pesticide approval] is just looked at in terms of a chemical that somebody wants to use so we will look at that chemical and see if is it safe. So actually there isn't a strong driver to say – well we don't need this." **NGO 30**

An organic farming view also comments that the first point of call is 'need' for the use of pesticides:

"I think there should be an overwhelming threat to human health before there should be any requirement to use synthetic pesticides in the environment. I would like to see similar rules applied to human medicines and similar consideration. I think to allow the production of food or garden plants or flowers, there is no need to use that justifies giving

clearance to these things [pesticides] at all. It is a position based on a view of need against risk. So it is not to do with safety". **Organic farming view, 17**

Given that organic farming rejects the use of synthetic pesticides, it could be argued therefore that supporters should not be part of the pesticide policy network as they reject the idea of a pesticide paradigm. The relationship between conventional agricultural and organic farming has after all been frosty over the years. But lobby organisations such as the Soil Association have entered the pesticide policy network as critical stakeholders, criticising the unintentional effects of pesticides[62].

In terms of pesticides, organic farming does allow some limited chemical use, but the desire is not to use such inputs. This, 'the desire', represents an important distinction between organic and conventional farming. This is because there is no denial of a 'problem', unlike conventional farming which sees pesticides as an acceptable part of the agronomic process. Any problems that do arise in the conventional system have to be accommodated within the remit of using pesticides. From an organic perspective, therefore, the question is not about the safety of pesticides, but it is about risk, and risk should be balanced against need. If a society needs pesticides badly enough, it will accept the risks they pose, and continue using them. This was the situation that existed in the UK in the 1950s. The current position is different, as an increasing number of stakeholders in civil society and some elements of the food supply chain are challenging the need for pesticides, and society's tolerance of them is in gradual decline as a result:

"I suppose one thing is to have an initial aim to get rid of anything that is just for cosmetic[63] purposes but that in itself is complicated because some pesticides used for cosmetic purposes may also be used for disease control as well. So is not always going to be a straightforward way of determining or eliminating which pesticides. But it certainly would be a way of eliminating quite a lot of pesticide usage, particularly on fruit crops. So certainly anything that is being used for that purpose should be eliminated. I suppose there would have to be some sort of way of showing that there really isn't a practical alternative currently available to farmers, including look at non-chemical uses...I don't think that the non-chemical option is really looked at properly. But again I think it is a complicated issue because even if there is a methodology available for organic farming, for example, again it is going to take time for that to be taken up by conventional farmers unless there is

62. See for example attending open meetings of the Advisory Committee on Pesticides.
63. Cosmetic use of pesticides includes usage designed only to improve the appearance of agricultural produce, rather than have a direct pest and/or disease management function. The term is also used to describe pesticide used in some urban settings, such as weed control in parks and gardens.

commitment from government to an extension service for example, so that farmers are re-educated in those techniques, so again it is not as straight forward and it is not something that can happen overnight. So you have to take farmers along the way." **NGO, 34**

This NGO response includes the desire to stop using pesticides, but recognises the difficulties in doing so. The interviewee is not resource dependent on the policy network for pesticide approval, unlike members of the food supply chain. But there is an acceptance that pesticides will continue to be used, at least in the short term. There is a realisation that pesticides cannot be dispensed with outright unless there is a change fundamental change away from conventional farming. This has the effect of locking them reluctantly into the paradigm. The public interest NGO resource dependencies within the pesticide policy paradigm are not bound into whether pesticides are approved because they do not directly need or use pesticides professionally, as the need would be for food supply chain stakeholders. They want to have influence with the network that contains a dominant pro-pesticide perspective within which they do not agree, or reluctantly accept because any other possible alternative paradigm is yet to gain sufficient momentum. The resource dependency is determined by the extent to which members of the network depend on each other for valued resources such as money, expertise and legitimacy, and whether most actors are self-sufficient. The public interest groups are self-sufficient in the terms of Rhodes and Marsh (1992), but nevertheless are 'captured' by the dominance of the pesticide policy paradigm, that productive stakeholders are at pains to defend. For example, even the argument against continuing the 'cosmetic' use of pesticides acknowledges that fundamental changes to the farming system would be required.

In conclusion, the dominant view within the policy network supports the pesticide policy paradigm. This is reflected in the framework of ideas around the economic productionist view. The public interest views framed around health and environment challenge the dominant view. The degree of need is an important component of the paradigm. There are views that are fundamentally opposed to pesticides, with different framing assumptions that are unlikely to be resolved unless this basic point is addressed.

8.3.2. Overview of the need for pesticides

The Table 8.3 presents an overview of the interviewee results according to stakeholder sub-group. An analysis of the sub-groups showed three groups. There are those supportive of the need for pesticides. This included the pesticide industry, and elements of all the other groups,

except the public interest sector. The second group expressed an equivocal response, essentially a need for pesticides was acknowledged, but so were negative connotations. The third group challenged the need for pesticides *per se*.

Table 8.3 Stakeholder overview on the need for pesticides

1. Pesticide production
• Pesticides allow for an intensification of production where products can get to market quickly **(Pesticide industry)** • Farmers struggle to get guaranteed crops of good quality if they do not use pesticides **(Pesticide industry)**
2. Research
• Chemical pesticides will always be needed – they just need to be improved **(IPM Expert)** • Pesticides should only be used when needed rather than as a prophylactic safeguard **(Horticultural researcher)** • The driver for pesticide development is whether a company feels it can make money from a product rather than whether a product is needed **(IPM academic)**
3. Control
• Pesticides are a part of modern farming, without them we would struggle to produce the level of food required for the UK **(Regulator)** • There are 'supposed essential needs' but in most cases, people find other ways of dealing with pest problems **(Regulator)** • In early decades pesticides were needed to increase quality – not sure today, it depends on wider agricultural policy **(Regulator)** • Safety is paramount and pesticide approval is not given on need alone – the drivers are economic **(Regulator)**
4. Experts[1]
• To produce the quality of food reliably at a price people can afford: they are essential absolute necessary • It is not really the role of ACP to look at need • The 'need' for pesticides is taken for granted • Pesticides make production of crops more efficient and increase quality • There is a presumption of need that pesticides are essential in production, but on the other side there is a presumption of no need what so ever
5. Food producers
• Without using pesticides on a national scale, the decrease in yield would be considerable **(Farmer)** • Need a capacity to produce a range of foods at a price people can afford **(Farmer)** • There is a need to produce food very efficiently and the use of pesticides is one of the structures of advice management (it left over from the Second World War.) **(Grower)** • It is a position of need against risk. It is not to do with safety. Is there a real need for them? No there is not, you can have a perfectly decent garden and a perfectly decent farm, perfectly good food without their use at all. **(Organic farmer)**
6. Food recall and manufacturers
• In the short term pesticides have to be used. It is the only sensible economic solution, although less toxic pesticides should be used **(Food manufacturer)** • Pesticides are need for the cosmetic quality and robustness (to withstand the food supply chain) **(Retailer)** • It depends on how much risk you perceive from the consumer (Retailer) • It would be nice not to use pesticides, but not sure this is achievable (Retailer)

• We are challenging the view 'we need pesticides – they are fantastic'. We are asking – is there a more integrated way? **(Retailer)**
7. Public interest
• Currently we are dependent on pesticides, but we could a have developed agriculture without high inputs **(NGO)** • Struggle to characterise the need because there are alternatives **(Media)** • The short term need is because of farmer-dependency. In the longer term they should virtually be eliminated **(NGO)** • Don't think there is a need for pesticides, a dependency has built up deemed difficult to break **(Independent Campaigner)**

Note: 1. Responses from members of ACP

8.3.3. Tensions within the network: responses to critical consumer views

This section shows that there are tensions within the pesticide policy network. The data from interviewees confirmed that there is limited horizontal interdependence within the pesticide policy network. There were a number of concerns raised by public interest groups concerning other elements within the network. This is particularly relevant to Question Three (see Table 3.2) concerning the difficulties and challenges around the pesticide debate. The background to these concerns, and why they occur, is presented from all interviewees (including those who do not themselves have fundamental worries about pesticides). One issue included the closeness between industry and government. A number of interviewees expressed a lack of trust in government. There was also scepticism from some about the use of science, and recognition that there is a lack of agreement between experts. The lack of consensus raises concerns within the public interest sector.

The concern from a public perspective about industry and government highlights the resource dependency that exists between the regulator and companies wishing to register pesticides. Industry spends millions of pounds researching and developing a prospective chemical product (see Table 6.2, Vol. 1, page 206). The safety data are detailed and has to be collected to certain agreed protocols. Assuming there is no improper contact between these two members of the network, an element of mutual trust and understanding has to develop in order for successful regulatory outcomes (pesticide approvals to occur). Transparency about the relationship between the two is important:

"There is also considerable, and in my view a far too close relationship between the agrichemical industry and the regulatory process... We know that the agrichemical industry has hundreds of lobbyists full time in Brussels, knocking on the doors of DG Sanco, DG Environment, DG Agriculture[64]*. The public interest view, in contrast, has a few dozen at best. So what gets decided behind closed doors and what gets decided in a more transparent process is not clear."* **NGO, 10**

"...the way agriculture developed post-war with this very, very close relationship between agribusiness and the Ministry of Agriculture...and the whole structure of regulation of pesticides and the funding of it is dominated by industry." **National consumer media correspondent, 27**

64. Offices of the European Commission

Public interest NGOs have consistently been critical of the pesticide industry and government. They do not have the same resource dependency on the other members of the policy network, but there is a concern about the paradigm that draws them into the debate. In this sense they have little to gain by agreeing to compromise, which is perhaps why there is little compromise given. There, concern centres on a democratic deficiency – that the NGOs are heavily out-numbered by industry lobbyists. It also reflects the unequal relationship. The strength of the current pesticide policy community, responsible for pesticide regulation, is exemplified by a former DEFRA minister:

> *"...the pesticides approval framework was long-established before I got there. I was never very comfortable with this process. I feel that at most stages it was influenced if not actually dominated by the chemical companies. I had a very uneasy feeling of relationships between the industry and either members of advisory committees or civil servants or indeed even in PSD that I could never quite pin down. I am not suggesting corruption but I cannot, in all honesty, say that there was no corruption. I simply don't know."* **Ex DEFRA Minister 19**

This view highlights the difficulty that a non-technical government minister has in having an influence on a long-standing network built around the original pesticide 'policy community'. It is they, the ministers, who hold the ultimate power within the network, but at the same time, this interviewee felt somewhat disconnected from it. Another former DEFRA minister commented on how little time he could devote to pesticide policy, given all the other responsibilities he had to cover:

> *"I would say it [covering pesticide policy] was maybe 2% of my time. I did visit the Pesticide Safety Directorate, I did talk to the pesticides industry, the various NGOs and the various bodies set up relating to pesticides. So I did have a fairly good impression of what was going on."* **Former DEFRA minister 45**

An anti-pesticide campaigner expressed the extent of the opposition when making fundamental challenges:

> *"First of all can I say the perception of many to date is that it is an emotive issue when it comes to the people who are complaining about it, or people who raise the problems. I personally disagree fundamentally on that because, in my experience the emotion and the emotiveness comes from the other side, when people are challenging the status quo, and putting forward a position where the whole of agriculture would have to fundamentally*

change to a different system. That is when you really do see. I have been at meetings where I literally had people raging in my face, who are conventional farmers, who are verbally abusing me, and I found it extraordinary. There I am with my facts and my figures, and my research and my evidence and my material and I put forward the position on this side of the coin, in a very professional and well-informed manner, and I have not found that so much is always the case, when you have people from the other side of the position, where there is so much propaganda, it's quite frankly a farce." **Independent Campaigner 47**

This sort of independent view cannot be accommodated by the pesticide policy paradigm. It highlights why the paradigm argument is so powerful. If it is challenged without compromise there is no solution but for a paradigm shift, which the dominant force will reject out of hand.

8.3.4. Consumer views:

The data above includes interviewee views on societal concern about pesticides. Canvassing public opinion directly was beyond the scope of this research. Information concerning these views is important because they help to explain why there is limited agreement horizontally within the pesticide policy paradigm network. Opinion surveys focussing on pesticides and other food safety issues are cited below. Indeed many of the interviewees (in government and industry) regularly commission surveys on public opinion and have views on their views. The following section reviews some of the research and surveys that have been carried out, and compares this with interview data in which some interviewees discuss their perceptions of the public's perception of pesticide residues in food.

A number of studies have found that food safety has become a major issue of public concern (Yeung and Morris, 2001, Canavari et al., 2002, de Jonge et al., 2004, Reijnders, 2004, Knowles et al., 2007). Furthermore, consumers are questioning the ability of the modern food system to provide safe food (Smith and Reithmuller, 2000). A review of the wide range of food scares reported throughout the EU between 1986 and 2006 shows that the incidence is increasing (Knowles et al., 2007). Specific incidents included 28 microbiological (eg *Salmonella, E. Coli*), 18 contaminant (eg residues, dioxins), and 11 Zoonotic/Epizootic (eg BSE, FMD). Problems can appear very quickly, without prior warning, and can cause widespread disquiet. A recent example included dumplings contaminated with organophosphate pesticide. They were made by a Chinese company whose products set off a nationwide scare in Japan after causing a number of health problems. Authorities had to recall millions of bags of dumplings after traces of the organohphosphates methamidophos and dichlorvos were found (Watanabe, 2008).

Specifically studies have addressed pesticide residues in food as one of the major food public safety concerns (Dunlap and Beus, 1992, Macfarlane, 2002, Reijnders, 2004, Knowles et al., 2007). A recent European Union survey of public perceptions of food safety concluded that pesticide residues were of greatest concern. When prompted, 63% of EU citizens interviewed voiced concerns about pesticide residues in fruit and vegetables. Pesticides rank higher than more recent technology such as Genetically Modified-based pest control (European Commission, 2006c). This concern has been recognised by food retailers, who are very sensitive to the concerns of their customers and/or the general public. Major retailers and food producers consider that consumers are willing to pay for substantially improved food safety (Reijnders, 2004). In terms of pesticides, residues in food are at the forefront of that concern. But one multiple food retailer was aware that there are wider issues:

"We have identified over a period of time through independent research that the consumer has some quite serious concerns about the use of pesticides. We have also identified, because of our ethical position, issues over the health and safety, and the handling of pesticides" **Multiple food retailer 06**

Customer research was saying that consumers were concerned about the levels of pesticide in food, and they didn't particularly trust the Maximum Residues Levels (MRLs) or government scientists who settle thresholds." **Multiple food retailer 08**

From these comments, it appears that trust is more important than technical details which are difficult for the lay person to understand. Researchers have found that 'social trust' is a key predictive factor for the perception of risks and benefits. Social trust has been described as the willingness to rely on those who make decisions related to the management of technology and public health and safety (Siegrist et al., 2000). It is an important factor for pesticides, and the implication is that some retailers consider social trust to be lacking for pesticides. Another food industry view is that a technical issue such as pesticides is difficult for the public to understand. It may be that consumers are vaguely aware of pesticides per se, but very few of them are aware of the 800 or so individual pesticide active ingredients that are used around the world to produce food from conventional farming:

"We know from research that we have done in the past that most consumers cannot name any pesticides. If they did remember one it is DDT. And you are lucky they remember that; they get confused with food additives and food colours and all manner of things." **Food manufacturer 20**

A multiple food retailer suggested that there is little consumer understanding of pesticides residues in food – but that absolute safety guarantees are expected:

"What happens is that consumers become completely confused about everything. They are confused about labelling [on food packaging]... an ultimately they are fatigued as much as anything... What the consumer wants, because mostly they just don't understand what you are talking about, they want unambiguously [the question answered] 'is it safe or isn't it?'... The difficulty we have is saying ' you should be concerned because..." **Multiple food retailer 31**

It is important to consider what is driving this concern. The headline response is one of concern. A deeper analysis has been carried out by the Food Standards Agency which has commissioned some qualitative research into consumer concerns about pesticide residues in food (COI, 2004). It was a more in depth analysis than the usual public opinion survey. Within their sample there were three broad attitudes with different levels of concern and information needs. There are 'avoiders' for whom pesticide residues are of negligible concern; 'mainstreamers' who show concern, but are reassured by authoritative announcements from government or through assurance schemes; and 'discerners' who have high levels of concern for both health and environmental impacts. This group is not trustful of regulatory authorities, and expect to see public interest NGOs involvement as well as governmental activity. Data from the interviews shows some of the stakeholders are 'discerners' too. This category would include some multiple food retailers. In the early 2000s retailer-commissioned consumer research was saying that consumers did not trust government scientists who set thresholds such as maximum residue limits (MRLs). This had important implications for the relationship between the retailer and government:

"For the first time we recognised that a regulator was not going to protect us, the consumer expectation had moved on and that was a huge shock to our system, and I think together with our initial desire to sell genetically modified food only to be told in no uncertain terms by our customers that they did not want GM. Those moments were seminal. Pesticide residues and non-GM food were seminal in our journey to become one of the most responsible retailers in the world". **Multiple food retailer, 08**

Some consider these concerns are the symptoms of a malfunctioning system, with pesticide residues one of the components, that can only be addressed through restructuring and reference to wider fundamental issues concerning the sustainability of the food supply chain.

The authorities and industry often express frustration with public's attitudes towards food risks, including pesticide residues (Macfarlane, 2002). This was reflected in the interviews. One of the scientific experts commented:

"I do not entirely know why people should be so much worried about pesticides than they are about most other things... In Sweden they are much more concerned about electricity than we are, power lines and mobile phones and things like that. So it does seem to be a cultural phenomenon. And there is an element of reinforcement within a society. Everybody in this country knows that pesticides are a bad thing, because there is a lot of publicity about it. And the campaign groups promote that message. The organic farming industry promotes that message actively and has a commercial interest in doing so as well. I am not saying that they do it because they want to get a commercial advantage. I think that, by and large, people in the organic farming industry are in it because they believe in what they are doing. But, in order to sell their products, they put their message across very forcibly, and it influences the way in which people think. And I think another major factor is that much of the use of pesticides, people don't recognise as providing them with an individual benefit. So they don't see any gain from it, they only see the adverse effects. And that is a very strong influence on how people react to risks" **ACP member 35**

This interviewee acknowledged that the issue is complicated and unresolved. Public concern was likely to be a combination of factors, but could not explain why it occurs.

Another point raised by one multiple food retailer was that the pesticide industry's customers are the agricultural supply industry and farmers or those applying pesticides on their behalf. Historically they have not had to reach out to consumers or the multiple food retailers when there was little general criticism of pesticides. As one retailer made the point that they were more attuned and responsive to consumers:

"The pesticide industry per se is not particularly consumer-facing. They see their customers as farmers as opposed to the end consumer of fruit or vegetables. If you look at the context of major brands or retailers whose immediate customer is the end consumer then almost inevitably they are going to be more aware of what consumers are saying. So you are faced with drivers at that point. One is if people are telling me they don't want this [pesticide residues] then I want to change it to satisfy that expressed desire. Secondly, whether you believe that by changing approaches you can add value to your brand, product or activity in a way that makes it more attractive to consumers... It is about having an awareness of potential risks and trying to manage those in a way that is practical and supportive of wider

society as opposed to just doing it for absolute profit. I am not saying profit isn't important." **Food manufacture 20**

There are other issues that are import to the 'tension debate' which are also dealt with, and cross-referenced elsewhere, in the chapter. The scientific risk assessment of pesticides is referred to in this section because the risk analysis of pesticides is not an entirely scientific process, and there are concerns among some NGOs that this is not recognised. An example of this is presented by the pesticide industry that is heavily reliant on the regulatory science within a technocratic model of risk analysis, whereas the regulators are more accepting that the risk analysis is in the final analysis political. This difference creates tensions elsewhere within the pesticide policy network.

8.3.5. Views on UK government departments

Concerns have been raised about differing pesticide policy views between individual government departments. One example came about after the creation of the Food Standards Agency (FSA) after 2000. The FSA was not given responsibility for pesticide regulation which was retained by the Pesticide Safety Directorate (see Section 6.4.1). The rationale for this was that there was more to pesticides than food safety, particularly in relation to agronomic and environmental expertise, and that the FSA would have limited knowledge and capacity in these areas. The regulatory consequences meant that the FSA has an interest rather than a responsibility for pesticides. But it did develop its own pesticide policy initiative in relation to reducing pesticide residues in food which conflicted with that of PSD. This example of differing policy views within the UK government puts pressure on the stability of the pesticide policy community, as explained by a horticultural grower:

"The FSA had its minimisation, or was it elimination of pesticides, two or three years ago. And it was basically one government department in conflict with another. You therefore had a very mixed message coming from one government department saying: 'we are totally safe, we are the PSD'. [In contrast] 'And we are FSA saying you are not safe'. So that had to be resolved politically... You then have a major problem because the politicians will make decisions which are very short term decisions that the NGOs and other people want them to make." **Grower 14**

The NGO view on government departments exemplifies the difficulty in influencing the decision-making process, and the emphasis on productive stakeholders within the pesticide policy paradigm:

"I have been to a couple of stakeholder forums where in terms of the presentations and on paper there were different views that were expressed form different stakeholder groups. Fine. But then you don't actually see how those views were then translated into the next stage of the policy design process. So it can be just window dressing with token consultation. Public interest groups think they have had their say, but it doesn't actually affect the decision-making process at all. There have also been some recent examples of abysmal public consultation processes by the European Commission as well where on one level they are transparent and open. They have internet based questionnaires. But there wasn't a chance to protest against the bias in those questionnaires. For example, one looking at the pesticides authorisation directive was totally focussing on possible costs to farmers and others of pesticide reduction without even considering there might be benefits." **NGO 10**

8.3.6. Views on retailer pesticide policies

A number of food retailers have established their own pesticide policies in response to concerns raised about pesticide residues in food. The impetus for this was public concerns about pesticides and other food health scares. But also the naming and shaming policy of incoming Labour government of 1997 meant that the names and locations of retailers selling food with pesticide residues above the maximum residues limits was publish annually by the Ministry of Agriculture Fisheries and Food (MAFF, 1999: 25). A retailer interviewee acknowledged the importance on this policy change:

"I think the naming and shaming issue has had a role, I think also... you should never hide away from the fact of brand reputation. At the end of the day, there was no doubt that, if you look at the produce industry, which I have worked for for 15 years, at the beginning there was no issue, but you could see as time went on that, having had food scares in other areas, other categories, that something was going to be raised within the produce area, and realistically the only thing that was going to be raised at that stage was pesticides... So you have got your bad reputation, on the back of media attention, naming and shaming... Also the fact that, through independent research – talking to our consumers – there was clearly a level of concern out there that needs to be recognised." **Retailer 06**

A fruit importer commented on the multiple food retailer initiatives within which their business is involved:

"We are involved in a supermarket initiative to reduce the overall risk of residue on fruit. They have asked suppliers to get together, all the suppliers of particular fruit, stone fruit or grapes, in vegetables as well, and to try an harmonise global use [of pesticides], because that is obviously one of the problems. One country might be doing something and another country doing something else... they [the retailers] had a list of products they felt were nasty and wanted to target products that may be were undesirable and if they could be replaced... I don't think they [the retailers] want to make it impossible for their producers to produce food with the quality they want. So that is why there are not dictating what can be used and what cannot be used." **Fruit importer 16**

8.3.7. 'Active ingredient' versus a 'pesticide' focus

There are three levels in which pesticides can be viewed. Pesticides are produced and regulated as individual active ingredients. Farmers and growers need a range of product formulations to control a diverse collection of potential pests as part of their pest management programme. These products contain a range of chemicals (often completely unrelated) that are released to control pests. As a result of these activities, there is environmental exposure to a mixture of pesticides and other synthetic chemicals in the environment. The food supply chain focuses on the first two levels described, but society as a whole is mostly concern with the third level. This level is the most difficult to control and understand, as it is the area about which least is known.

A farming view explained the difficultly in explaining the need and function of pesticides as a group, because farmers need a range of different products for the pest control requirements:

"I am not sure you could summarise [the functions of a pesticides] because it depends on what it is for. It depends what it is trying to do in what circumstances so you could have one compound, say something like pirimicarb[65], which could be used to kill aphids on cereals which is very much a threshold based, loss of a certain amount of quality, loss of a certain amount of yield versus cost, or the same thing on lettuce, where people will not buy

65. A carbamate insecticide.

it if it has got an aphid on it, to apples and things like that where pirimicarb is more selective than chlorpyrifos,[66] *for example."* **Farming view 32**

The unintentional effects of pesticides are difficult to control because of the diffuse nature of the pollution caused. This presents problems for those who defended the pesticide paradigm. A member of the ACP expressed satisfaction with the pesticide approval process, but a different view post application:

"...where my concern starts to come is as we get nearer and nearer the end user - as to how and to what extent they observe the label regulations. And sometimes the way regulation works actually creates difficulties for the end-user, such that they are more likely to use the product in a way that is not approved, because of the way it is tightly regulated. Yet, on the other hand of course, for the vast majority of farmers and growers, the regulation does ensure that they use it safely and properly." **ACP member 33**

Assessing the potential effects of an individual active ingredient is easier because it has been subjected to scientific testing as a part of the registration process. It is far more difficult, if not impossible, to provide pre-approval data on the health and environmental impacts of diffuse pollution. The complexities and difficulties are enormous, and the suggested solution is to prioritise the most important concerns, according to a toxicologist member of the ACP:

"...what I am absolutely clear of, is, you cannot take every pesticide, and pesticides are not unique molecules, so why classify them separately? We've got thirty thousand chemicals out there which we are exposed to at reasonable levels. We can't think of a risk assessment that would look at every possible combination of all 30,000 chemicals. It would consume the entire GDP of every country from here to eternity. What we have got to do is find a way forward that says these are the possible interactions that are really potentially important and then think of a way of looking at them. And in fact there is now a lot of activity both nationally and internationally to develop such a scheme." **ACP member 36**

The 'economic production' view of those who work within the pesticide policy paradigm and the food supply chain is focussed on the particular active ingredient to guarantee pest control. This provides the framework for the regulatory approval of the product based on the safety data, and what the farmer uses. Primarily the questions are framed with a view to the agronomic efficacy of the individual product. Wider society, with a 'health and environment'

66. An organophosphate insecticide.

view is not concerned with this process; it is concerned about the unintentional impacts of pesticides, as a diffuse group.

8.3.8. Market failure for pesticides

The present research argues that modern regulatory requirements for pesticide approval are putting severe pressure on the pesticide paradigm. Most of the interviewees would not be expected to have a comprehensive view on this issue, outside the pesticide industry. According to the pesticide industry websites, a new pesticide costs about €200 million to research and develop (see Vol. 1, page 205). An industry interviewee explained the process in more detail:

"If you actually look at one active substance, the discovery of one substance and all the tests on that substance, the cost is less than €200 million. But the reason it is €200 million, you start off screening 140,000 compounds to get one, so you include in the €200 million, the cost of screening 140,000; you include then... out of those 140,000 you take x number, say a couple of hundred to stage two while the cost of doing the work on those substances for stage two is also part of the €200 million. And you would take, probably I think it is about four or five compounds onto the real development stage of actually doing the intensive testing, even though you are testing on five, you only get one at the end of the day, so the costs that you have linked to those five are also factored in." **Pesticide industry 26**

The interviewee explained the extent to which company research and development funding is expended on prospective pesticides that are close to market registration but which do obtain regulatory approval. They fail at a late stage showing the demands of 'regulatory science' means that the majority of the €200 million R&D spend per successful pesticides is spent on pesticides that are never used commercially. Another interviewee pesticide industry interviewee said it could be argued regulatory failure has already occurred:

"... Some people would argue that we have got to market failure today because we have gone down from 12 main R&D companies to only 6 today. And you could even actually argue that today you don't have six you have three possibly four. I mean you have three market leaders in Bayer, Syngenta and BASF, the three European companies. Monsanto doesn't do any agchem R&D anymore, for new substances. And the two other American companies Dow and Du Pont appear to be questioning their commitments to it in the long term. So the fact that in 10 years, we have gone from 12 major companies really committed

to this area down to a handful today. Is that market failure, possibly? It is definitely getting more difficult to get the new substances onto the market." **Pesticide industry 26**

The pesticide industry is concerned about the regulatory burden for pesticide approval. An economic report produced for the pesticide industry has indicated that the outcome of proposed new EU regulation (more stringent than the current Directive 91/1414) might be to reduce the capacity of the pesticide industry to produce new pesticides (Nomisma, 2008). According to this report, the draft EU regulation (as of January 2008) could result in 60% of current pesticides being banned, which could reduce cereal yields by 20% by 2020. The European Commission forecast, however is for a 20% reduction (Anon, 2008b). The pesticide policy paradigm argument is that the new regulation should be more restrained. The alternative view is that this provides further evidence that the paradigm is under serious pressure. That is not the argument for the present research, where the regulatory failure indicates severe pressure on the pesticide policy paradigm, which is in need of fundamental change away from the chemical approach to pest management.

8.3.9. Why is there concern about pesticides?

Table 8.4 shows that there were a wide range of responses from the interviewees. Although the colour bars in the table represent some common thoughts (see key below), which can be broken down into stakeholder sub-group. There is no statistically significance to these results, but they are never indicative of what the concerns are. Concerns about pesticides (uncertainties in the risk assessment and the possibility of chronic effects), and issues of trust were raised by many of the public interest NGO interviewees and some food retailers. From the production, regulation, expert, and food retailer side, frustration was expressed with a general inability to explain a technical issue in simple terms. There are different views about the relative roles of science and policy/politics. Nobody rejected the need for scientific input to inform the process, but the pesticide industry response placed greater emphasis on science; whereas the (exclusive) regulatory view concluded that ultimately the decision to approve a pesticide is political. This means that other factors come into play, especially the economic need. (This issue is also addressed in the Risk Analysis section). Pesticides were also considered as an irresolvable issue until more fundamental questions are addressed. These included asking whether we should be using pesticides at all; addressing a wider social context; and the fact that pesticides are locked into a wider farming process. The following summarises common responses from interviewees:

- Ignorance: Difficulties in explaining a technical issue to the public
- Decisions about pesticides are political

- Concerns about political decisions bigger emphasis on science
- Not addressing fundamental issues
- Concerns about pesticides (uncertainties, chronic effects) and/or trust

Table 8.4 Stakeholder views: why are there concerns about pesticides?

1. Pesticide production
• Explaining the science is very difficult **(Pesticide industry)** • Science is king: once we move away from science we have no end of problems **(Pesticide industry)** • We have a tough time convincing the public: perception is reality **(Pesticide industry)** • The is public ignorance about pesticides and regulation **(Pesticide industry)**
2. Research
• Consumers want blemish-free food; and yet do not want pesticides applied **(IPM Academic)** • We are not asking fundamental questions – why we should be using pesticides at all. **(IPM Academic)** • The name 'pesticide' obviously sets alarm bells ringing **(Horticultural researcher)**
3. Control
• Method of pesticide application in farming has been 'cavalier' at times **(Former Minister)** • Pesticides are part of wider social context **(Pesticide industry)** • Ultimately, the decision to approve a pesticide is political **(Regulatory view)** • Consumers are widely unaware of pesticide issues, but there is a wider interest in the food supply as a result of BSE **(Regulator)** • Decision to approval a pesticide is always political **(Regulator)** • Regulators should make decisions on a basis of law and science, but cannot deny they live in a political environment **(EU Regulator)**
4. Experts[3]
• Mind-set can vary according to fundamental views **(ACP)** • It is very difficult to put over a case when it is highly technical **(ACP)** • There is a problem with people's understandings of pesticides **(ACP)** • There is a polemic of views, do not really know why entirely – an element of reinforcement within society **(ACP)** • We require a higher level of science to overcome uncertainties **(ACP)**
5. Food producers
• There are a few genuine people affected by pesticides frightened by press sensationalism **(Grower)** • There is dominant political and economic interests defending pesticides **(Organic farmer)** • No matter what you say, some people will not change their attitudes **(Farmer)** • Pesticides are locked into a wider farming processes – cannot just switch off pesticides – would have to change the way of farming in a huge way **(Farmer)** • Public concerns are down to historical problems **(Farmer)**
6. Food recall and manufacturers
• Consumers have serious concerns about pesticides **(Food retailer)** • Consumers have a lack of trust in government; and retailer has been let down by government **(Food retailer)** • There is a consumer lack of awareness about pesticides **(Food manufacturer)**

- The likelihood of pesticide problems occurring can be difficult to predict **(Food retailer)**
- Consumers are not at the forefront of consumers or Pesticide Safety Directorate **(Food manufacturer)**
- Residues in food and cocktail effects are a big worry **(Food retailer)**

7. Public interest

- Concerned about the closeness between industry and the regulator, coupled with a lack of public debate about risks **(NGO)**
- Concerned about the cocktail effect **(NGO)**
- It is not an issue of safety, it is a matter of trust **(Media)**
- Scepticism in science, lack of scientific agreement and concern about uncertainties **(NGO)**
- There is always a lot of interest in residues in food from NGO supporters **(NGO)**
- **(Pesticide industry)**
- **(Independent campaigner)**

8.3.10. Summary: Key findings

The data from the chapter helps to characterise the pesticide policy paradigm network. It also examines interviewee views on societal concern about pesticides. This has come about because of public concern about pesticides. The technical nature of pesticides is difficult for experts to explain in simple terms. Uncertainties in the science mean that overall trust is more important than explaining obscure technical acceptability limits. A number of themes emerged from the analysis of stakeholder interviews to help explain why the pesticide policy paradigm is challenged and under pressure. These include views that the need for pesticides should be questioned. This strikes at the core of the support for the continued use of pesticides and its policy paradigm. There is little internal coherence across the pesticide policy network. There is too much trust vertically (developing, approving and using pesticides) and not enough horizontally (such as civil society NGOs), putting added pressure on the paradigm.

The reason pesticides are used is economic, they play an important part in conventional agriculture. For many productive stakeholders, this still holds. For some other productive stakeholders there is recognition that the need for pesticides should be challenged, especially as the conditions under which pesticides originally developed have changed so significantly. Other productive stakeholders have challenged the policy paradigm network. Some multiple food retailers, normally part of the vertical integration, have broken ranks.
Food retailer's trust in government has been eroded, but they still need a pesticide policy paradigm if they are to carry on selling conventionally produced food. Whilst maintaining links vertically, they have also engaged horizontally with public interest groups. These retailers have to take responsibility for the risks of selling food to consumers with residues in food whilst not having direct control over pesticide use and control. They are too far down the food supply chain, and therefore have to take responsibility for the actions of others. They are, in a sense, productive stakeholders who also have had to become a critical stakeholder. This is why they have developed their pesticide policies.

There are critical stakeholders in terms of proponents of organic farming who do not see a need for pesticides. With this perception one could ask; why take the risk with the pesticide paradigm? Effectively they are excluded from the network, except as critical stakeholders.

These critics new and old have added to the pressure on the pesticide policy paradigm network. It includes a membership with three types of world view that otherwise frames their thinking. There is the 'health and environment' view of critical stakeholders and the 'economic production' view of the productive stakeholders. In the middle there is an economic view trying to incorporate the concerns of the health and environment view. These shifts of view also have taken their toll on the paradigm.

Finally there is the political versus science argument between industry and the regulator. This is not particularly transparent, and the present research argues it is an underlying tension at the root of wider discontent. As the pesticide industry says, science is the key, and without it the pesticide policy paradigm would suffer and would be in the hands of those who have the greatest power. Those who control the science have the power; and without the science the paradigm falls.

8.4. *Findings on views of alternatives to pesticides -- bio-pesticides and the ecological debate*

The term 'bio-pesticide' is used to describe biologically based pest control products, derived from, or consisting of living organisms. Three sub-groups include: 1) Plant-based chemicals such as garlic and mint oils; 2) Semio-chemicals such as pheromones; 3) Microbials such as viruses and bacteria and fungi. The term bio-pesticide is defined in the same UK and EU law as for synthetic pesticides. The phrase 'bio-control agent' is used by those who market these products as a term that represents the above three groups plus invertebrate bio-controls such as nematodes and insects (which are not covered by the same legislation as bio-pesticides.

This section presents the findings from interviewees concerning the use and development of bio-pesticides, one of the emerging alternative options to using synthetic pesticides. Synthetic pesticides remain the dominant method of pest management, despite pressures on the pesticide policy paradigm. There are at the same time opportunities for bio-pesticides, but they too have barriers which have the potential to impede further development.

The first section of this chapter presents data on the regulatory procedures for bio-pesticides. It shows that there have been changes at the UK level which have led to a more pragmatic regulatory regime. Some of the regulatory barriers have been reduced in recent years through the adoption of a bio-pesticides scheme introduced within the Pesticide Safety Directorate. The regulation for invertebrate bio-control agents is less complicated, although some extra risks are identified for these agents. The second section covers the market potential for bio-pesticides, another traditional barrier for development. The third section makes a comparison between the pros and cons of pesticides and bio-pesticides. The final sections include an overview of stakeholder comment on the appropriateness of bio-pesticides and how they fit within a wider debate on an emerging ecological pest management paradigm.

The interviewees for this chapter were drawn largely from the pesticide policy network. This included the bio-pesticide producers as well as other stakeholders who are also part of the pesticide policy network. The list of stakeholder sub-groups is presented in Chapter Three (see Table 3.1). The bio-pesticide producers have the advantage, as a group, because of their relatively detailed knowledge of bio-pesticides, compared to most pesticide stakeholders. Familiarity with bio-pesticides varied among pesticide stakeholders overall. The majority had some comments to make, but often the terms had to be explained by the interviewer prior to receiving a response.

Bio-pesticides provide one alternative to synthetic pesticides. They are not the only alternative, but are the main focus of the present research. The need for bio-pesticides emerged as both political and commercial. There is a perception that they represent a safer alternative, and would be politically more acceptable compared with synthetic pesticides. The interviewee cited below considered the advantages for bio-pesticides to be environmental benefits, low development costs, supermarket support and a reduction of synthetic pesticides on the European market. Despite the potential advantages, the global market is much smaller than the synthetic pesticides market, although it is increasing at a relatively fast rate (see Vol. 1, page 211):

"I would say there are various reasons for the need. One is the reduction in the number of registered active ingredients for conventional pesticides, conventional crop protection products and that is perhaps providing an incentive to growers to look for alternatives. But I think as well there have been concerns from growers, from the public, about the use of insecticides, herbicides and fungicides, as well if we go back to the costs of registration, for a chemical company for a market like the UK, it is relatively small." **Bio-control producer 38**

Despite the advantages, the development of bio-pesticides is off-set by a number of barriers to further market development. One has been the regulatory costs of bio-pesticides, especially when developed by small businesses with small research and development budgets. The interviews confirmed that there is concern from International Bio-control Manufacturers Association that in some countries the increasing regulation restricts the availability of alternatives to synthetic pesticides. The size of the marketing potential is another limiting factor. These issues are described in more detail below.

8.4.1. Regulatory approach towards bio-pesticides

This section examines the challenges and opportunities for the regulation of bio-pesticides. As discussed in Chapter Four, bio-pesticides are regulated under the same legislation (UK and EU) as synthetic pesticides (see Figure 6.4). The UK regulator (Pesticide Safety Directorate) has traditionally requested prospective bio-pesticide companies to submit the same level of regulatory safety and efficacy data as for synthetic pesticides. Bio-pesticides were therefore treated in exactly the same way as synthetic pesticides (see Section 6.8.2). In the UK this proved a significant barrier for the introduction of new bio-pesticides which led to complete regulatory failure. Between 1990 and 2004 no bio-pesticides were registered in

the UK (Whittaker, 2007). In order to gain regulatory approval for bio-pesticides, detailed dossiers had to be produced. They had to address the same potential health and environmental risks as required for synthetic pesticides. Generally companies marketing bio-pesticides could not afford to register bio-pesticides because they are typically small enterprises with limited research and development budgets. The challenges of regulating bio-pesticides have been investigated by two research projects: The EU Regulation of Biological Control Agents project (REBECA, 2007) and the UK Rural Economy Land Use (RELU) programme on the role of regulation in developing biological alternatives to pesticides (Greaves, 2006, Chandler et al., 2008a, Chandler et al., 2008b). One way of addressing this is to allow for the production of collective dossiers, so that small companies can share the costs of registration. How this is done in practice remains to be resolved (Bradshaw et al., 2004).

A number of questions about the regulation of bio-pesticides were discussed by interviewees. Is it appropriate to regulate bio-pesticides in the same way as synthetic pesticides? What are the additional risks for bio-pesticides that do not apply to pesticides? Some of the bio-pesticides are biological agents which can reproduce and, in theory, have far-reaching ecological impacts. On the other hand biologically based plant extracts are chemicals, so why should they not be treated in the same way as synthetic pesticides?

Government funded research was being carried out, but there was nothing reaching the marketplace (Greaves, 2006). Pesticide Safety Directorate (PSD) has responsibility for regulating bio-pesticides, and yet the interviews acknowledge that they had little expertise or knowledge about these potential products. PSD had built all its proficiency around the safety and efficacy of synthetic pesticides. Looking back to the earlier 2000s, an interviewee from PSD accepted its limitations at that time:

> *"...we would have to be honest and hold our hands up and say at the start of it [the regulation of bio-pesticides] we couldn't say we were experts, we would have to build that knowledge up."* **Regulator, 22**

In this case the regulatory response was to over-regulate, according to another regulator (as explained by the interviewee below. This is characterised by taking a restrictive stance, refusing to approve and regulate bio-pesticides because they did not how to carry out these tasks. It emerged that there is a level of trust also has to develop between the regulator and the organisations that are directly being regulated. A food industry interviewee further explained the difficulty a regulator has in dealing with small businesses (producing bio-pesticides), when the previous norm involved multinational companies (producing synthetic

pesticides) with well established and highly technical regulatory affairs departments. As long as there is a longstanding professional understanding between the regulators and the commercial enterprises developing the technology, the science-informed processes will follow with a greater degree of success:

"I think that that is a problem which is not understood from the industry side - if the regulators feel unsure about something, feel unsure about a risk, they tend to over-regulate. Many companies in the bio-pesticide sector, many small companies wouldn't have any idea about the legal procedure and also the formal process; but they feel that they have to add a value to mankind and so they perceive often the normal problems in the process so that when the authorities come back to ask you some questions and clarifications, they often perceive it as a sort of personal question – as an act of mistrust in their person or their work and they tend not to react and not to act in a very professional manner. And that creates some communication problems in the whole process. So that's for me the main reasons. As soon as we can overcome that, we are going to make also faster process." **EU Regulator 46**

This view underlines the concern over the lack of trust between the regulator and the industry applying for product approval.

One bio-pesticide interviewee explained the lack of prospects for regulatory approval in the UK. Again looking back to the early 2000s, it is acknowledged the regulatory process for bio-pesticides existed in a very rudimentary form:

"The first two or three meetings we had [with PSD] were totally adversarial... [This was] because they had no checklist for it [for the regulatory process]. Either you go through the whole process as it is for a pesticide, or you go away. [the applicant was told]" **Bio-pesticide company 21**

Another bio-pesticide producer was concerned that there is a regulatory gap as far as this area of regulation is concerned:

"I believe there is a gap in the regulatory process at the present time in that the attitude that we get from Pesticide Safety Directorate UK is that they treat the bio-pesticides in the same manner as the synthetically developed material. One thing that bio-pesticides often have on their side that synthetics don't is that there is a long history of usage sometimes going over hundreds of years. That is never used by the regulatory authorities to actually

underpin the toxicity, human exposure and so on within a bio-pesticide application." **Bio-pesticide company 07**

The regulatory attitude of the time was summed up by a (non PSD) UK regulator who received a rather unscientific response after putting forward a biological control suggestion to the Advisory Committee on Pesticides a few years ago:

"I was presenting some information [to the ACP] on a chemical for controlling aquatic weeds, and we were talking about what we would do without that chemical. I suggested that we might be able to identify a biological control agent for some of the weeds... and that was met by hoots of derision by the ACP, at the time, which I was flabbergasted at – the idea of suggesting a biological control agent!" **Regulator 25**

At that time, the framing assumption of the committee from this response was not conducive to bio-pesticides, although the ACP has since produced a detailed report on biological alternatives to synthetic pesticides (ACP, 2003a). In summary however, the bio-pesticide industry saw the regulator as a block for market development, which was recognised by the regulator:

"...we, along with other regulators, definitely got a lot of stick. There is no doubt about it we were seen as the big barrier. And, you can understand why." **Regulator 22**

During 2004, the attitude of the UK regulator to bio-pesticide approval changed. PSD responded to calls to take a more pragmatic approach and developed a bio-pesticides programme, within the confines of the existing pesticide regulatory institution. As indicated above, pressure had been forthcoming through the recently formed UK branch of the International Bio-control Manufacturers Association (IBMA). As a new organisation, it had yet to establish credibility with the UK regulator. Interviewees who are members of the IBMA credited the change in regulatory attitude to the efforts of a food industry expert who happened to be seconded to the UK Cabinet Office. In turn, the expert put his influence down to a chance encounter with a special ministerial advisor:

*"...that was how we **really** made things move. He [the ministerial adviser] could apply the right pressure to PSD as well. In fact they could not but listen to him. Because I gave him all the ammunition and he gave it to them, in as much as: 'you are out of line with government policy, you are not helping in green innovation; you are not this, you are not doing that; come on guys what can you do? Although I have to say that they did stonewall*

for a long time and then just one day, one meeting, the two of us could not quite figure out what made it change, but they just changed. Half way through a meeting they just went: 'OK we'll do it'. Whether it was attrition or they saw the light, I don't know." **Food manufacturer 29**

The link between high government policies was made, providing PSD the opportunity to be seen to follow a sustainable option, as required by their own government department. The bio-pesticides scheme came about opportunistically. Two key people happened to be in a position that could help deliver a change of policy within PSD. They drew on their positions within at the centre of government to lobby for a bio-pesticides scheme. A PSD respondent agreed that there was external pressure saying that PSD was a barrier. But once the decision was taken, the regulator took on the responsibility in a way that impressed the following bio-pesticides interviewee:

"I've said it in many open forums over the last five/six months that the approach the PSD is now taking is extremely pragmatic, extremely helpful, and I consider it to be a major progress step on their side." **Alternatives company 21**

The PSD interviewee explained that the reason for carrying out the pilot bio-pesticides project was to build up expertise. It aimed to do three things:

"One was to gain the confidence of companies that, the developers, because sometimes they are not companies, to actually talk to us. The second one was to build our own expertise. And then the third challenge to my staff was to say OK we've set these fees as a pilot – how are we going to deliver for that permanently. And the pilot ran in the end for two years or so, and we got three approvals through it and, as a result of that from 1 April this year we have gone live with a permanent bio-pesticide scheme for which we will charge £22,000 basically for a biological £13,000 for a pheromone and £22,500 for a plant oil. And we have now got our own website page purely for the bio-pesticides. Our longer term aim is now to start putting all our advice on there. At the moment it is just the opening page for bio-pesticides to say the scheme is there, to announce our bio-pesticides champion." **Regulator 22**

As part of the scheme, PSD held pre-submission meetings with companies registering bio-pesticides. These provide specific guidance for applicants so that regulatory advice can be offered at an early stage of product development. PSD appointed a 'Bio-pesticides

Champion' to help applicants through the approval process, and a new bio-pesticide area of the regulator's website.

For pheromones, PSD accepted an Organisation for Economic Cooperation and Development (OECD) guidance document for a group of Lepidopteron pheromones[67] that contained all the known toxicity data for these chemicals (OECD, 2001). This 'group assessment' waiver is different from synthetic pesticides for which separate safety data has to be submitted. This saves the registering company hundreds of thousands of pounds in research and development costs, as the generation of data for an approval dossier can cost £300,000 (Cole, 2004). As a result of the changes, three new bio-pesticides were registered: a pheromone to control codling moth in apple and pear orchards; a virus for protection of Cucurbits; and a fungal agent for the control of *Sclerotinia,* a fungal disease in agricultural, horticultural and ornamental crops. The number of bio-pesticides registered in the UK is nevertheless still small compared to other countries. In the US there are 78 microbial and 160 biochemical bio-pesticide registered (Whittaker, 2006), and in Canada there are 45 bio-pesticides registered as part of its 'reduced risk pesticides' programme (Health Canada, 2005). In the UK, there are still only 6 biopesticide registrations, including three additions since the bio-pesticide programme was introduced (Whittaker, 2006). The situation is different in the US because of a publicly backed 'IR4 Programme' through the Environmental Protection Agency. It oversees US$ 30 million per year of research funding to develop research and submit appropriate data. Fund also support demonstrations to growers, and efficacy testing is not part of the US system, which saves registration costs (Cole, 2004).

8.4.2. Invertebrate bio-control

Invertebrate bio control agents do not come under Directive 91/414, and are not therefore regulated as the bio-pesticides above (see Figure 6.4). There are no controls of the introduction of native invertebrate biological control organisms. In the UK, non-native invertebrate biological control organisms are regulated through advice from the Advisory Committee on the Releases to the Environment (ACRE) which is provided to ministers and officials at DEFRA. In the rest of the EU the situation varies, according to a bio-pesticides respondent:

"In some cases it is assigned to the environment department, in some cases it is the pesticide regulator, in some cases it is not assigned to anybody, and in plenty of cases they haven't got a clue" **Bio-control company 38**

67. This includes all straight chain Lepidopteron pheromones with carbon chains from 9 to 20.

Some health experts have concerns about the impacts on operators producing and applying mites for invertebrate control. According to one senior member of the ACP:

"There are endless populations of people who have become sensitised to mites and develop rhinitis asthma. When introducing another mite, you have to bear this in mind that it could be a sensitizer. I think from my point of view, they are inadequately policed at the moment"
ACP member 44

It emerged that invertebrate bio-control agents have the potential to present extra risks compared with synthetic pesticides. For a non-native invertebrate species there would need to be an estimate of the likelihood that any introduction did not trigger any unwanted side effects such as a population explosion. This is a scenario that does not apply to risk analysis process for synthetic pesticide. There is also the impact of indirect effects (although regulators do not receive information about the indirect effects of pesticides either). How broad spectrum is the predator? For example, if a nematode is released against aphids in cereals, might it also affect non target ground beetles? These are the examples of the questions that should be asked prior to release. Some other examples were presented by one of the bio-control interviewees:

"Will the organism establish, is that a problem?
If it is not a problem, what is the extent of the risk?
Is it a local risk, how far can it travel – more than a kilometre?
Can the organism survive the winter?
How many generations are there per season?
What about testing for the host-range?
What is the risk of a polyphagus predator versus an oligophagus predator?"
Bio-control 38

There are also some areas where extra care may be needed in the future. In the years to come, climate change may have an impact on some of the above parameters.

8.4.3. Marketing of bio-pesticides

Another barrier for bio-pesticides is their market potential compared with synthetic pesticides. One of the first problems raised within the food supply chain is the name 'bio-

pesticides' chosen to represent this group of alternatives. According to one horticultural expert:

"I think the name pesticide obviously sets alarm bells ringing which is why I was disappointed that the Pesticide Safety Directorate had called it the 'bio-pesticides scheme' because it infers that it is a product which could cause harm. I think the problem is that people have a perception that... it is like pollution... as soon as people have a perception, it will stick. And really I would have preferred the bio-pesticides scheme to be called something more like 'biological control approvals', or something that takes away the word 'pesticides'." **Horticulture 15**

Bio-pesticides do struggle economically when compared with synthetic pesticides. According to a farming view:

"The costs are simply too high for the market. The markets that are out there for these products are relatively small, especially for cereals, there are enough natural fungal pathogens out there." **Farmer 32**

The barriers are not just economic, there are more fundamental differences. According to Dent and Waage (2000) there was an expectation that pesticide companies would take a lead in product development of bio-pesticides in the 1980-90s. In addition to the regulatory barriers, this never materialised because of technical constraints posed by bio-pesticides. It is difficult for companies producing synthetic pesticides within a pesticide paradigm to convert to producing bio-pesticides. The research and development processes are different. They are technically complicated to use, compared with synthetic pesticides. Fundamental change is wider institutional frameworks would be required. Gaugler (1997) characterised the paradigm for commercialising bio-pesticides as being based on a chemical pesticide model. This paradigm is suited to major crops and is based on cheap, stable products (that do not break-down easily in the environment) and are easy to scale up and use on a wide scale.

The management of bio-pesticides is different from that of synthetic pesticides, and new techniques have to be learnt. Bio-pesticides are not as easy to use as synthetic pesticides. A multiple food retailer interviewee, who works with growers and suppliers, explained the use of a *Bacillus* microbial bio-pesticide:

"It isn't particularly effective, because one of the things that we haven't learnt is how to use it. It has got a very short shelf life and farmers struggle to actually manage to get it live

from in the tin onto the crop and it appears to need very specific conditions in the field to work. So to date, the actual practical work on farm has been very limited in its effects. But the farmers say "Well it's not a no-no. It's just we have got to learn how to use it."
Multiple food retailer 37

One perspective from a member of the ACP registered concern about efficacy levels when considering botanical products on the Committee's agenda:

"Some of these [products put forward for registration] have been botanical products, and as a person concerned with effectiveness, a lot of the data for some products was dubious. OK in integrated pest management you don't necessarily need 100% [pest] control, but you need some sort of consistent level of control at a level". **ACP 04**

"The farmer's view is of efficacy [in relation to bio-pesticides] which detracts from a bio-pesticide unless they have an education programme associated so that they know that it will respond differently, because the farmer is used to a pyrethroid [insecticide] but if he uses Bacillus thuringiensis... and it takes an absolute age to kill the insect. In his terms it is not working well... The educational requirement associated with alternative bio-pesticides particularly is phenomenal in terms of famers and their use." **IPM expert 05**

8.4.4. Chemical versus natural: a comparison

A comparison between synthetic pesticides and bio-pesticides is summarised in Table 8.5. There are problems of wider societal perception of both bio-pesticides and synthetic pesticides because of the historically negative perceptions of anything with the word 'cide' in it. Indeed that is why the pesticide industry refers to pesticides as crop protection products and the bio-pesticide lobby refers to bio-control agents. One thing that is common to both bio-pesticides and synthetic pesticides is the regulatory reality that, by and large, they have to be examined on a case-by-case basis. Each individual product is unique and therefore requires bespoke discovery, commercial development, and regulatory examination. Most interviewees referred to a resonance with the natural processes associated with bio-pesticides compared with synthetic pesticides. Most of the interviewees were equivocal; instinctively they were supportive of bio-pesticides, but this support was often followed with caveats. Certainly there was no carte blanche support, which was a recognition that some bio-pesticides were of more potential concern than others.

Most food chain interviewees assumed during interview that the consumer will also prefer bio-pesticides over synthetic pesticides. There is a great deal of market research data on general altitudes towards synthetic pesticides (see Vol. 2, pages 39-41) and there is an assumption among the stakeholders that the corollary of this is support for bio-pesticides. The present research has revealed no widely available published market data, or academic study on consumers' attitudes towards bio-pesticides. There is a gap in the knowledge which needs to be filled. As a food safety regulator said:

"I don't think we have specifically asked those questions [covering consumer views on] natural pesticides." **FSA personal view 28**

The equivocal nature of the partial support was illustrated by two public interest views with some familiarity with the subject:

"...having come from an integrated pest management background, and having studied biological control, that makes me generally agree with the fact that most biological pesticides do inherently have fewer hazards than chemicals. So I would agree with the fasting-tracking [for regulators to approve their use]. That is not to say that you make a blanket recommendation [for approval for use]. And certainly some plant extracts like nicotine and rotenone can actually be toxic." **NGO 10**

"My gut reaction is they [bio-pesticides] because they are organic, they are going to degrade. But actually in practice you need to be just as rigorous with these things because there can be unexpected and equally damaging impacts." **NGO 43**

There is already evidence that some public interest groups in the US have concerns about the use of bio-control agent pheromones. Albany City Council banned the aerial spraying of a pheromone to control the light brown apple moth after adverse health effects were reported from local residents. Anecdotal evidence from the Pesticide Education Watch Fund reported 648 cases of negative health effects that may have been linked to the spraying; symptoms included asthma-like attacks, difficulty in breathing, chest pains, headaches, blurred vision, swollen glands, skin rashes and chronic fatigue (Anon, 2008a). The implications from this report are that it cannot be taken for granted that there will be automatic support from public interest groups. It may be that the concerns are also linked to the manner in which the pheromone was applied – in this case by wide-spread aerial application over large areas of the California districts Monterey and SantaCruz. This is a process that mirrors the use of synthetic pesticides, rather than an ecological or integrated pest management approach.

Nevertheless, for some bio-pesticides, such as pheromones, there was a view from interviewees that a much more limited data set is required, compared with synthetic pesticides. According to one ACP member:

'There needs to be a proper scientific assessment of whether one can make assumptions that they [bio-pesticides] are safer. And what you try to do is to ensure that the risk assessment for any product is appropriate to the nature of the product. You don't have a 'one size fits all'. So you don't apply the same risk assessment for a microbial or a pheromone as you would for a chemical pesticide that was applied directly to the crop. It has to be scientifically appropriate and certainly for pheromones, we went on a much more limited evidence base than we would have expected from other classes of pesticide because of the nature of their use, the way in which people were exposed, and what we knew about them already. One of the issues was whether they might disrupt other benign arthropods and other Lepidopterons' **ACP member 35**

This has raised the question of whether regulatory fast-tracking is appropriate for invertebrate bio-control agents. In the US and Canada, there are products that go through the approval system quickly because there is a recognition that they do not have the inherent hazards that many synthetic chemicals do. But there are still words of caution from the public interest sector, which reflects uncertainty on its part.

The food residue profiles for bio-pesticides are better those for that of synthetic pesticides. This is proving very attractive to multiple food retailers who have overriding policy objectives to reduce and even eliminate pesticide residues from the produce they sell.

In concluding this section, Table 8.5 summarises an analysis of the differences between pesticides and bio-pesticides, as reported in and collated from the interviews. There are a series of technical, practical and economic differences outlined for pesticides in the left-hand column (of Table 8.5) and bio-pesticides in the right-hand column. The left-hand column requires a pro-pesticide defence of the paradigm supporting continued use and development and the right-hand column requires a new paradigm, unless bio-pesticides are used by the pesticide policy community as a complement to the pesticide paradigm. In this case the regulatory and food supply chain resources will 'drive' bio-pesticides into supporting the pesticide paradigm.

However, the incompatibilities could result in the two separate paradigms: pesticide and ecological pest management. The more integrated approach of bio-pesticides relies on less powerful chemical intervention and provides a more sustainable pest management paradigm. But this requires regulatory and policy changes in the private and public sectors. To switch from one to the other in Hall's (1993) terms (see Vol. 1, page 26) would require a third order shift. It is not simply a case of replacing pesticides with bio-pesticides, as is being proposed and developed at present. A dramatic departure in policy goals based on a new set of framing assumptions framework is required. There would need to be a restructuring of the regulator to accommodate fundamental changes to farming systems. The agricultural and food supply systems themselves would need to have new advisory and development systems.

Table 8.5: Comparison between bio-pesticides and synthetic pesticides

Components of a pesticide paradigm	Components of bio-pesticides
1. Synthetic chemical focus	Naturally based
2. Single active ingredient and single pest control focus	Linked to integrated approach or holistic approach (e.g. organic farming); and not just one pest solution.
3. Synthetic pesticides are often more powerful and have greater potential for adverse health and environmental effects	Bio-pesticides tend to be less powerful and therefore less harmful
4. Broad spectrum effects with unintended consequences to humans, wildlife and the environment	Many (but not all) bio-pesticides are host-specific and only affect the pest species, leading to less ecological impact
5. Easy to use by farmers/pest control operators, and usually very effective	Technically complicated, with new skills required compared with synthetic pesticides
6. Quick pest control results, easy to observe by farmer/operator	Results can take days to materialise, making results difficult to observe
7. Easy to market (long shelf life)	Difficult to market (short shelf life, often supplied on demand)
8. Long shelf life can perversely lead to persistence in the environment	Usually have low persistence in the environment; although can have potential for biological persistence because released biological organisms can reproduce and develop beyond their immediate area of pest control
9. Often used prophylactically, as an insurance against the possibility of pest and disease build-up, rather than applying pest control action because of a direct need	Used as a result of pest forecasting, only when needed. Biological agents cannot survive without pest hosts (or an alternative organism on which to host)
10. High potential for resistance to develop in pest(s) to lethal effects of pesticides.	Resistance less likely
11. Immediate emphasis is placed on research and development of active ingredient for high volume market potential and efficacy, rather than on impacts which is secondary	Emphasis on an organism-level approach such as bacteria and insects as a pest control agents
12. Pesticide policy stakeholder group well established, originally small and strong but now large, diverse and contested	Bio-pesticide stakeholder group is less well established, and weak.

8.4.5. Need to open the debate

This section draws on interview data that links bio-pesticides with synthetic pesticides on the one hand and the development of an ecological approach to pest management on the other. A number of NGO and academic interviewee suggested that needs to be a wider debate about pesticides and their role in society. The public interest view and some of the multiple food retailers called for a wider a public debate about pesticides. One of the NGOs called for a bigger role for a stakeholder group that has a strategic overview. One member of the Advisory Committee on Pesticides argued that the current system of pesticide approval does not deal with the wider issues of pest management; he also commented that DEFRA had been created in 2001 with different overall aims compared with what it replaced – the Ministry of Agriculture, Fisheries and Food. A food supply manufacturer considers there is scope for external stakeholder engagement within the process.

In linking pesticides to wider policy a number of issues need to be taken into account. For example farmers realise that they cannot work at a 'one spray in one field level.' In addition there are wider pesticide issues that are not taken into account through the approval system, such as resistance management or pest management as a whole. One view put forward by an NGO whereby the staring point should be: how to deal with particular pests and diseases, instead of the whole emphasis being on approving particular products.

8.4.6. Is an ecological paradigm emerging?

A key feature of the development of bio-pesticides is that they lack a public profile. Many interviewees felt that bio-pesticides resonate with natural processes; but all raised potential concerns. The environmental benefits of bio-pesticides conflict with the practical challenges of marketing them. The better the health and environment profile, the less effective the products seem to be. There are many difficulties fitting bio-pesticides into a pesticide regulatory process. And there is a problem with a simple substitution of pesticides to bio-pesticides because they still represent a technical response rather than a shift to a sustainable farming system philosophy.

A number of interviewees (NGO, Farmer, and academic) noted the disconnection between bio-pesticides and broader farming systems. Bio-pesticides are knowledge-intensive and challenging to use. Bio-pesticides tend to be developed as a single response to a chemical alternative, for example posing residue problems. They are developed piecemeal, rather than as part of a wider farming strategy.

8.4.7. Summary: key findings

This section has included a review of interviewee reaction to bio-pesticides. It is of value because there is little data on this subject. A key finding is that there is no information in the public domain on civil society opinion on the use of bio-pesticides.

An important first step in the discussion about bio-pesticides surrounded the *need* for bio-pesticides, and what was/is driving that need. There has been an increasing political call for the development and up-take of safer alternatives to synthetic pesticides. This initiative has come from public interest organisations with concern in this area. At the same time, there is a lack of public profile for bio-pesticides. This means it is not clear whether there is wider public support for these products. The stakeholders currently *assume* this to be the case. Some areas of the food supply chain are also interested in replacements for synthetic pesticides, especially for products which do not leave residues in food and drinking water. The potential environmental benefits of bio-pesticides were raised, as were some of the efficacy and marketing challenges. There clearly has been a difficulty in retro-fitting bio-pesticides into the synthetic pesticides regulatory process. In some cases, bio-pesticides are seen only as a way of reducing pesticide residues in food. In this case, they represent a technical fix within the pesticide paradigm, rather than part of a new ecological pest management paradigm.

Overall the responses from the stakeholders varied across the groups, with positive aspirational comments about bio-pesticides on the one hand, and cautious negative practical provisos on the other hand (see Table 8.6). The public interest response mirrored this. On the one hand, they would like to see fast-tracked safer alternatives quickly developed and approved for use; but as a note of caution, a number of recent food chain scares have made them cautious of new advancements. The regulators were they one sub-group that did not have any totally negative comments about bio control agents, although there were many equivocal statements. An EU regulatory interviewee did conclude that regulating bio-pesticides was more difficult than regulating synthetic pesticides. This does seem run counter-intuitively to the other comments that a lighter regulatory touch was required. This coupled with the equivocal and widespread comment that there is a theoretical welcome for bio-pesticides but doubts about the practicalities, suggests that there is uncertainty with the technology.

Table 8.6 Stakeholder overviews of pros and cons for bio-pesticides

1. Production
• An advantage for bio-pesticides is that farmers do not like the negative environmental effects of synthetic pesticides and there is a potential to sell produce to supermarkets **(Bio control industry)** • There are economic barriers as bio-pesticides are not included in the 'money making crops' **(Bio control industry)** • Not convinced by different [lower] 'heights of [regulatory] hurdles' **(Pesticide industry)** • The commercialisation and efficacy of bio-pesticides present difficulties for bio-pesticide development **(Pesticide industry)** • We do not have the research and development set up for bio-pesticides **(Pesticide industry)**
2. Research
• There is a need to fast-track the regulatory approval of reduced risk chemistry provided by bio-pesticides **(Horticultural researcher)** • The public image of bio-pesticides may be compromised if they are linked with the technology of genetically modified foods **(IPM Academic)** • Public demand is perceived as a driver for bio-pesticides, but there are few drivers for new products **(IPM Academic)** • There are concerns that microbial bio-pesticides pose extra problems above and beyond those posed by pesticides **(IPM Academic)**
3. Control
• The regulatory regime for bio-pesticides can be lightened where appropriate; but some microbials are no safer than chemicals **(Regulator)** • Bio-pesticides may seem to be safer, but this can be more difficult to prove compared with synthetic pesticides – for synthetic pesticides there have been many years of experience and trust between industry and regulators **(EU regulator)** • There is little known about public opinion towards bio-pesticides **(Regulator)** • There has to be a case-by-case regulatory assessment as to whether bio-pesticides are benign or not **(Regulator)**
4. Experts
• The opportunities for bio-pesticides as products or for pest management systems are enormous • In the case of pheromones, the ACP would accept much more limited evidence • It assumed that 'natural' bio-pesticides are less harmless, but this is not proven and a rigorous assessment must be carried out • Bio-pesticides must be assessed on a case-by-case basis • There are concerns over 'grey products' [products with implied pesticidal properties] as there is scant data on safety and efficacy
5. Food producers
• If all results showed that a natural chemical is more benign, a lower efficiency could be acceptable **(Farmer)** • The costs of developing bio-pesticides is too high for the market **(Farmer)**
6. Food recall and manufacturers
• Bio-pesticides may not be as efficacious as synthetic pesticides, but the added

sustainability value means that lower yields can be afforded **(Food manufacturer)**

- There should be a fast-tracking system for products that are genuinely more benign **(Retailer)**
- Unless data is generated for bio-pesticides, we do not have the comfort factor of knowing whether it is not toxic or carcinogenic **(Retailer)**
- Cannot afford to be seen to put our customers as risk – but the difficulty with bio-pesticides is the cost **(Retailer)**

7. Public interest

- It is not logical to apply the same [expensive] tests as those required for synthetic pesticides if there is no residue issue for the bio-pesticide **(NGO)**
- The is a call for fast-tracking bio-pesticides – but this does not constitute blanket support **(NGO)**
- Will not endorse bio-pesticides just because they are natural **(NGO)**
- Supports for natural non-chemical control if on a case by case basis **(Independent campaigner)**
- Gut reaction is supportive of bio-pesticides, but experience merits caution **(NGO)**
- Bio-pesticides are not on the consumer 'radar' – but not assume that bio-pesticides are 'great' **(Media)**
- Caution: bio-pesticides can reproduce and have different side effects **(NGO)**

There is no doubt that the bio-pesticide stakeholder group is less well established and weak compared with the pesticide stakeholder group. Although the pesticide stakeholder group encompasses internal dissent, the relationship between industry and the regulator is well established.

All bio-pesticides have risks associated with their use and in some cases the risks are different from the risks posed by chemicals released into the environment. From analysis of the stakeholder interviews, one could speculate how the public might react. Want is important are the underlying principles supporting their use. If bio-pesticides are used as a simple alternative to a synthetic pesticide, and within a similar intensive farming system, there is unlikely to be widespread public support. If on the other hand they are used within a bio-rational approach as part of an ecological paradigm, the sustainability in this case is more likely to engender support.

9. Discussion and Conclusions

This chapter describes the present research model for pesticides, derived from the analytical framework and informed by the empirical data presented in the findings chapters. This chapter begins with a summary of foregoing Chapters Four to Eight. Subsequent sections reflect on the conceptual framework developed in Chapter Two. There follows a discussion of some constraints on the present research, and areas of possible future research.

The proposition of the present research is that **the pesticide policy paradigm is under threat and that an alternative ecological pest management paradigm is emerging in its place.** This generates three key research questions:

1. **Is the concept of a paradigm useful in describing pesticide policy and development?**

2. **What impact does pressure on the pesticide policy paradigm have on the governance of pesticides?**

3. **What are the prospects for a paradigm shift from a pesticide to ecological pest management?**

9.1. An emerging pesticide paradigm

This section will establish that a pesticide policy paradigm emerged during the 1940s and 1950s. Modern synthetic pesticides were developed over a remarkably short period of time. They were one of the technical responses to the military necessities of the Second World War. The research confirms that in the early years of pesticide development, the framing assumptions of the researchers, government scientists and the pesticide industry did not adequately test and assess the unintentional effects of pesticides, such as long term adverse environmental consequences or chronic health effects. The priority then was to produce pesticides that worked. In the immediate post-world war two era, the militarily-derived pesticide technology was transferred opportunistically to peacetime purposes. In particular, the greater efficacy of synthetic pesticides helped secure UK agricultural policy objectives in which security of food production was very important. Agricultural policy benefited from war policy. After the war there was a concerted effort by the key stakeholders to organise a

system of producing pesticides. There was a realisation that the acute effects of pesticides on human health could have undesirable consequences, but the over-riding motivations still hinged around increasing food production. The key stakeholders with an active role in governing the development of synthetic pesticides included government, scientific research and advice agencies, the farming industry, and the agricultural supply industry. As an integral part of intensive agricultural production, pesticides helped to increase food production.

The initial pesticide stakeholder group driving this has been found to be small and strong. It focussed on efficacy, and firmly believed in the economic need for pesticides. The group had a common set of ideas and beliefs that supported the development of pesticides. They were what the present research has called 'productive stakeholders' who are part of a 'policy community'. This group of stakeholders, and their inter-connected institutional background, played an influential role in the defence of the pesticides policy paradigm. An historical analysis is important because the parameters of the pesticide policy paradigm are in a constant state of flux, requiring defence and development from within.

Pesticide technology was locked into the developing conventional agricultural system. This heralded the beginning of a chemical age for pesticide use and development. There was limited internal criticism or wider disagreement within the stakeholder group, and these drivers led to the rapid research and development of new pesticide products and an increasingly widespread uptake and usage by farmers. Chemicals were cheap and effective, and offered comprehensive pest control. The new synthetic pesticides presented for some supporters of the pesticide paradigm the idea of a 'silver bullet' for pest management. All pesticide stakeholders existing within what the present research calls a 'pesticide paradigm' had a common interest in maintaining the paradigm. This internal harmony also produced a series of predominantly voluntary agreements for the control of pesticides. In this situation, regulation was an extra financial burden that was deemed unnecessary because all parties agreed on the course of actions being taken.

9.2. Scientific evidence for threats to the paradigm

Over the last 60 years, a growing body of scientific literature has emerged linking adverse effects with exposure to pesticides. These unintentional side effects challenge the validity of the original pesticide paradigm. Assessment now focuses on the risk of adverse health outcomes and the extent and chronology of environmental pollution. The present research has constructed a model to demonstrate the 'intentional and unintentional pesticide cycles'

(see Figure 5.1, Vol. 1, page 133). The breadth of the literature drawn on reflects the wide range of relevant research disciplines.

Many of the side effects of pesticide use are highly variable in their manifestations. There is variability in the manner of pesticide dispersion. Pesticides can travel and affect humans, domestic animals and wildlife through the media of air, food and water. In all such situations there is the potential for variable exposure.

There are many variants in terms of the possible results of human contamination by pesticides. There is variation between susceptibility of human beings in relation to their gender, age and genetic susceptibility. The duration and length of exposure also varies. There is the multi-factorial nature of the causation of many diseases that may be mediated by interaction between pesticide toxicity and other pathogenic factors, leading to a number of adverse health progressions such as carcinogenesis, abnormal neuro-developmental and disorders of immunological, reproductive, and neurological systems. The precise mechanism of the toxic action at a cellular and sub-cellular level is variable and often uncertain as with endocrine disruption and genotoxicity. There are even implications across generations where variable adverse outcomes may occur in children whose parents were exposed to pesticides. It is impossible to isolate one variable factor for study and assume all the other factors are constant.

In many cases, when pesticides are applied, the bulk of the product is released into the environment and only a small amount actually kills or controls the target pest. This is the main source for the 'unintentional' effects of application (see Figure 5.1, Vol. 1, page 133). Pesticide residues are ubiquitous – in the air, in precipitation, in surface water, in groundwater, and in the soil. Chemical contamination occurs in the bodies of wildlife, of domestic animals and of humans; and in crops and other food plants. Often this contamination is in the form of multi-residues. From all of these sources of contamination there is a constant threat. Acceptable levels of pesticides are found regularly to have been exceeded so that active monitoring has to be carried out as a matter of routine.

Important areas of uncertainty have emerged. There is uncertainty in estimating the dispersal of pesticides in terms of what is used, where it is used and when it was used. There is uncertainty in estimating pesticide drift. The exposure of people resident in rural areas seems likely to have been substantially underestimated. The true extent of pesticide poisoning is not known. At best it has been chronically under-reported. The ability to link human disease and

environmental chemicals is difficult and not least because of the multi-factorial nature of most diseases.

New risks from exposure to pesticides represent a recurrent theme. All the adverse health outcomes referred to present an elevated risk for those exposed to pesticides.

The known risks have increased over time, and are still increasing as more data about the impact of pesticides becomes apparent. Indeed many of the studies concerning the risk associated with exposure to pesticides were published after the present research had commenced. The present research has identified 11 areas of new risks that have developed over time (see Table 5.1, Vol. 1, page 176). These included many of the chronic effects mentioned above, accentuation of the genetic predisposition to autism by environmental chemical contamination, and the possible impact of pesticides on exocrine disruption[68]. As these new problems emerge, they exert additional pressure on the pesticide paradigm.

These four themes, 'variability', 'ubiquity', 'uncertainty', and 'new risks', have emerged as the key factors driving the 'unintentional' pesticides cycle. Added to the historical significance of pesticide use (as outlined in greater detail in Chapter 2) they reinforce the problems that have been encountered and highlight failings that have previously gone un-noted. They are the essence of the health and environmental concerns posed by the 'unintentional' pesticide cycle (see Figure 5.1). The four themes are all difficult to define scientifically, but the collective evidence strongly suggests that there are many increased risks associated with the use of pesticides.

9.3. Responses to threats

From the 1960s onwards, independent criticism emerged outside the initial pesticide 'policy community' because of previously undiscovered adverse health and environmental effects of pesticides. The following section summarises the response to the threats to the pesticide policy paradigm and the locked-in technological trajectory that followed in order to defend the paradigm.

In the UK one example took the form of a House of Commons report that linked organochlorine insecticides with significant wildlife mortality. It recommended an immediate

68. An exocrine disruptor is a chemical substance that mimics or disrupts pheromone activity. A pheromone is a chemical that triggers a behavioural response in another member of the same species.

ban on the use of a specific type of pesticide-coated seed dressing. This was, belatedly, carried out. The publication of Rachel Carson's *Silent Spring* in 1962 had a bigger impact on wider society because it was written in an authoritative but popular style. She was heavily criticised by those supporting the orthodox pesticide paradigm, even though she was only calling for greater restrictions on the indiscriminate nature of pesticide use.

The pesticide paradigm was repeatedly challenged leading to an increased and more diverse group that included new actors who joined the pesticide debate from a critical standpoint. The present research refers to these as 'critical stakeholders'. This resulted in a wider 'policy network' which included all stakeholders whether supportive or critical of the pesticide paradigm. The government and industry responded belatedly to these problems by providing more research data in support of their challenged pesticide paradigm.

Another response, to defend the pesticide paradigm, was to introduce protective legislation. Subsequent pressure on the paradigm led to increasingly stringent legislation. When new products were promoted, they had to satisfy safety requirements, where previously registered active ingredients had been considered acceptable until adverse effects were discovered. The prospect of pesticide legislation was resisted by both the government and the pesticide industry. However, by late 1970s, it was clear that the UK government did not have sufficient toxicological and related expertise to cover the impact of pesticide legislation. The pesticide industry was concerned that legislation would result in political interference in the regulation of pesticides. The prospect of pesticide regulation in the mid 1980s allowed critical stakeholders to enter the political debate when pesticides legislation was being discussed. A 1980s pesticide campaign organised by Friends of the Earth centred on the demand for pesticide legislation. Other pressure to legislate arose from the consequences of a wider EU environmental agenda. This led first to the enactment of the UK Food and Environment Protection Act 1985 and then to the EU pesticide Directive 91/414, which the UK was obliged to draft into UK law by the mid-1990s. When subsequent problems emerged for a particular pesticide, or group of pesticides, the result was new regulation and/or additional research. The reaction of government and the pesticide industry has been defensive and reactive, responding to potential problems with pesticides dismissively, rather than embracing them.

An early opportunity for the UK regulatory process to take a progressive initiative was lost. Pesticides legislation for the UK was first drafted by the expert committee advising government in 1967, but it was not enacted until 18 years later in 1985. So long as there was a sympathetic relationship between the pesticide industry and the regulator, costly legislation

(for both parties) could be avoided. Furthermore, during the 1970s, the government used the threat of legislation to oblige the pesticide industry to self-regulate. The similar tactics were used in the 1990s by the regulator when the threat of a tax on pesticides forced the industry to set up a voluntary initiative to reduce the adverse environmental effects of pesticides.

Even then change only came about because of pressure from the European Union, and campaigning by critical stakeholders. The introduction of legislation on pesticides by the German legislature put the German pesticide industry at a competitive disadvantage compared with other European national pesticide industries that had a lighter regulatory regime. The Germans therefore pressed for EU-wide regulation so that there would be a level regulatory regime. The cost of regulating pesticide through legislation would threaten the existing pesticide paradigm. There was also a growing awareness of the difficulties of 'regulatory science' using the uncertainty inherent in scientific endeavour in an attempt to produce legal certainty. When legislation did arrive, a large national regulatory department and complementary industry regulatory departments had to be set up. This 'reactive regulation' was characterised by delayed regulation that eventually called for new legislation. Compared with the 1950s, the regulatory burden has increased substantially. A relatively light regime up to the 1990s meant that over 1,000 separate pesticide active ingredients were approved for use across Europe. Since then, the cost of bringing new pesticides to the market has increased, and the number of pesticides has halved, and is set to decline further. In the 1950s, only very basic data were required, and there was little public concern about pesticides. By the 2000s the information requirements are much more detailed, there is a well established group of critical stakeholders and there is much wider public concern. All these factors combine to put sever pressure on the pesticide policy paradigm, and the ability to sustain food production by conventional agricultural methods.

Another quite different response to enable the reduction of synthetic pesticides usage is their replacement by biologically based alternatives. They cannot, on their, own replace synthetic pesticides outright, but they are being used increasingly because they are seen as safer alternatives. Demand has been driven by consumers' desire to lower pesticide residues in food. Major food retailers have responded to support this desire. There is also government pressure to minimise the environmental impacts of chemical pesticides. Areas of commercial potential include organic, integrated pest management, and resistance management programmes.

The definitions of biologically based pest control products are contradictory, depending on the legal definition of 'bio-pesticides' or the industry term 'bio-control agents'. This is

because bio-pesticide contains within it the word 'pesticide' and all the negative connotations that go with it. As a result, most bio-pesticides (plant extracts, semio-chemicals, and microbials) are considered within the same legal framework as synthetic pesticides. They are therefore subject to the same pressure that has been placed on synthetic pesticides, in terms of the extra safety data requirements and all the same research and development costs. The bio-pesticide market is dominated by small and medium enterprises, or even start-up enterprises that have only one new technology with a market potential. The multinational pesticide companies have a limited involvement in the bio-pesticide market. One reason for this is the paradigm incompatibility between synthetic and bio-pesticides. Synthetic pesticides are designed to have a long shelf life, and to act quickly and be used against a broad range of pests, whereas most bio-pesticides do not meet the requirements.

There are examples in which bio-pesticides have been rejected by the Advisory Committee on Pesticides because of efficacy concerns. Unlike the situation for synthetic pesticides, there is little information in the public domain about bio-pesticides, and no consumer opinion feedback. There are regulatory opportunities for bio-pesticides to replace synthetic pesticides through comparative assessment and substitution. This would constitute a fast-tracking system such as exists in the United States and Canada.

During the period of the present research, a bio-pesticide scheme for the UK regulatory system has been established, as a response to the barriers presented above.

9.4. Stakeholders: a fragmented community

The range and number of stakeholders has grown since the 1940s, when they consisted of a small cohesive group largely involved in the production, development, distribution and use of pesticides. These productive stakeholders have had to adapt to pesticide policies aimed at reducing the adverse health and environmental effects of pesticides. These policies have included initiatives from the government operated National Pesticides Strategy (NPS) and Pesticide Forum and the Voluntary Initiative run by the pesticide industry.

These institutional pressures have presented their own extra additional challenges. This has occurred through additional regulatory involvement (other than from the lead regulator Pesticide Safety Directorate [PSD]) from a different perspective and which has increased over time. These also include the Food Standards Agency (with its pesticide residue minimisation policy), the Environment Agency and Natural England. There are also the implications resulting from the transfer of PSD as an executive agency from the Ministry of

Agriculture Fisheries and Food (MAFF) to the Department for Environment, Food and Rural Affairs (DEFRA) (when the MAFF was abolished in 2001 and replaced with DEFRA).

PSD also has to work regionally within the EU framework, at the OECD, FAO and WHO. However a strategy at a pesticide policy level is generally devolved to the national level, as recognised by the EU Thematic Strategy on the Sustainable Use of Pesticides.

As a result of widespread debate and dissemination of opinions and knowledge, the public as individuals and groups of individuals have increasingly mobilised political pressure at local and national levels. Since the 1980s, these 'critical stakeholders' have entered the UK pesticide policy arena. They have developed their own pesticide policies which often conflict with the productive-stakeholder policies. This includes the NGOs, who want to see an overall reduction in use, whereas industry contends you can reduce risk without necessarily reducing usage levels. They have been joined in recent years by multiple food retailers, who have new progressive policies which ban the use of certain active ingredients which the UK regulator considers acceptable to use. They also have stringent targets for zero residues in the food they sell.

There are multiple pesticide policies in the UK, which are not all mutually exclusive. The UK regulator is developing the NPS pesticide policy which is stakeholder dependent, where there is common ground and the views of the strongest lobbyists tend to prevail.

9.4.1. Current stakeholder perspectives on the pesticide debate

Findings from 47 interviews with stakeholders confirmed that the pesticide paradigm is under pressure from critical stakeholders, and from technical and regulatory challenges and faces a collapse. The paradigm is being defended by productive stakeholders, who see the development of bio-pesticides as a way of supporting the pesticide paradigm, rather than part of a paradigm shift to ecological pest management.

Overall, the findings showed that productive stakeholders still perceive an overwhelming economic need for synthetic pesticides which are indispensable to conventional agriculture. Stakeholders involved in the regulatory element of the pesticide policy network acknowledge that there are presentational difficulties communicating the risks associated with pesticides. For them, solving this issue is paramount. Public interest groups and some food retailers argue that there is a public lack of trust in the regulatory process, and that uncertainty cannot be eliminated by improved risk communication techniques. Critical stakeholders have also

raised the fundamental policy question of the need for pesticides. Such a view has to be seen in the context of a wider agricultural and food policy because of the dependence of the current conventional agricultural practice on synthetic pesticides.

The analysis of stakeholder interviews confirms that there are many different views concerning the use of pesticides. Interviewees were invited to discuss the role of the precautionary principle in relation to pesticides and the regulatory process. There was widespread support among public interest NGOs for hazard cut-off criteria that lead to an active ingredient ban. Some stakeholders (scientific experts and regulators) supported the principle, but had concerns about the political context in which it can be used.

The precautionary principle is designed to accommodate what current scientific knowledge cannot yet accommodate. There are uncertainties within the risk assessment process that are unquantifiable, and therefore the decision includes an element of sound judgement. A decision has to be made as to whether a defined level of uncertainty is acceptable, given the economic, social and political need for a particular pesticide.

The principle can be seen as:

- a mechanism for achieving significant reduction in pesticide use
- leading to greater openness to criticisms from outside, and increasingly within, the food supply chain of the pesticide regulatory process
- an encouragement to the examination of alternative products and systems for pest and disease management

The difficulty in dealing with some uncertainties is acknowledged by members of the ACP. It also acknowledges the limitations of 'regulatory science' in delivering absolute regulatory outcomes. Risk communication involving the risks of complicated technical issues is very difficult, according to some scientific experts. The fundamental problem is that consumer 'dissenters' and critical stakeholders within the pesticide policy network are growing in number and making an impact on the food supply chain. Their concern is not about being re-assured around the uncertainties within the risk analysis process; it is about acknowledging that these uncertainties are unacceptable per se, and that alternatives need to be considered.

The precautionary principle embraces the co-evolutionary model (see Vol. 1, pages 42-43) of risk analysis, and there are concerns about this from the pesticide industry and some sections of the food supply chain. Their view, that science dominates, is more in line with a

technocratic risk model. The regulatory view while acknowledging the scientific input, puts greater emphasis on the political reality of the pesticide regulatory process. This difference in emphasis acts to reduce cohesion within the regulatory element of the pesticide policy network. The ACP experts also acknowledge the intervention of risk management into the risk assessment process, no matter how much the desire is to separate the two. This suggests the UK is moving away from the traditional technocratic approach to risk analysis, but in a way that lacks transparency for outside observers. For the EU, where risk assessment is separate and carried out in one organisation, and risk management in another, there is a concern that the risk management will lose touch with the risk assessment process. For re-connection, an integrated compromise has to take place. The risk assessment process is changing all the time, becoming more complex, and therefore difficult not only to assess but also to manage. This applies extra pressure to change the pesticide paradigm.

Stakeholders are divided over separating risk assessment from risk management: those for a separation cite conflict of interest; those against argue risk managers lose touch technically with risk assessors if they are separated. Pesticide registration is a political not a scientific decision (disputed between industry and regulatory stakeholders).

One overall conclusion from the UK stakeholder interviews is that there is a general lack of detailed awareness of and familiarity with the EU process. This is disconcerting because these stakeholders have experience of involvement in UK pesticide policy at a time when pesticide regulation and policy development is gradually passing over to the EU. It suggests that the national stakeholders are in many cases losing touch with the regulatory process and will struggle with policy implementation that is formulated under the umbrella of the EU.

Findings from interviews highlight the way in which the regulatory process has become focussed on the assessment of individual active ingredients, and less on pesticides generically. In order to defend the pesticide paradigm, the regulatory process has increasingly had to focus on monitoring and assessing the collective health and environmental consequences of all the active ingredients that make up the milieu of pesticide formulations applied.

Some themes have emerged from the analysis of stakeholder interviews that have added to the explanation as to why and how the pesticide paradigm is challenged. The fundamental question of *need* is at the core of the continued use of pesticides and their policy paradigm. There is little internal cohesion across the policy network. There is too much trust vertically

(developing, approving and using pesticides) among the productive stakeholders, and not enough horizontally (such as civil society NGOs), among the critical stakeholders, putting added pressure on the paradigm. The reason pesticides are used is economic. They play an important part in current conventional agriculture. For many productive stakeholders, this still holds. For some other productive stakeholders there is recognition that the need for pesticides should be challenged, especially as the conditions under which pesticides originally developed have changed so markedly. Other productive stakeholders have challenged the policy paradigm network. Some multiple food retailers, normally part of the vertical integration, have broken ranks.

Multiple food retailers' trust in government has been eroded, but they still need a pesticide policy paradigm if they are to carry on selling conventionally produced food. Whilst maintaining links vertically, they have also engaged horizontally with public interest groups. They are, in a sense, productive stakeholders who also have had to become critical stakeholders. This is why they have developed their own pesticide policies.

These critical stakeholders new (such as multiple retailers) and old (the NGOs) have added to the pressure on the pesticide policy paradigm. It embraces three types of world view that otherwise frames their thinking. There is the 'health and environment' view of critical stakeholders; and there is the 'economic production' view of the productive stakeholders. In the middle there is an economic view trying to incorporate the concerns of the health and environment view. These shifts of view have also destabilised the paradigm.

Finally there is the divergent political emphasis of the regulator versus the scientific emphasis of the industry. This difference is not particularly apparent, and the present research argues it is an underlying cause of tension at the root of wider discontent. As the pesticide industry says, 'science is king'. Without science the paradigm fails. The use of science helps to support the pesticide paradigm, but it can also used to challenge it. Those who control the science have the power to support the paradigm and resist a shift other alternatives.

Bio-pesticides as an alternative to pesticides

This section includes a review of interviewee reaction to bio-pesticides. It is of value because there is little data on this subject. An important first step in the discussion about bio-pesticides surrounds the need for bio-pesticides, and what is driving that need. There is an

increasing political call for the development and up-take of safer alternatives to synthetic pesticides. This initiative has come from public interest organisations with concern in this area. At the same time, there is little public knowledge of bio-pesticides. It is not clear what the public reaction would be to the wide-spread adoption and use of these products as a replacement for synthetic pesticides. The stakeholders widely assume general approval to be the case. Some areas of the food supply chain are also interested in replacements for synthetic pesticides, especially those which do not leave residues in food and drinking water. The potential environmental benefits of bio-pesticides have been raised, as were some of the efficacy and marketing challenges. There has clearly been a difficulty in retro-fitting bio-pesticides into the synthetic pesticides regulatory process. In some cases, bio-pesticides are seen merely as a way of reducing pesticide residues in food. In this case, they represent a technical fix within the realms of the pesticide paradigm, rather than being part of a new ecological pest management framework.

The range of responses from interviewees varied across the groups with positive aspirational comments about bio-pesticides on the one hand and cautious, negative, practical reservations on the other hand. The public interest NGO response has generally mirrored this. On the one hand, they would like to see fast-tracked safer alternatives quickly developed and approved for use; but as a note of caution, a number of recent food chain scares have made them wary of new advancements. The regulators were one sub-group that did not have any totally negative comments about bio control agents, although there were many equivocal statements. An EU regulatory interviewee did conclude that regulating bio-pesticides as an issue is more difficult than regulating synthetic pesticides. This does seem to run counter-intuitively to the other comments that a lighter regulatory touch was required. This, coupled with the equivocal and widespread comment that there is a theoretical welcome for bio-pesticides but doubts about the practicalities, suggests that there is uncertainty with the technology.

The 'bio-pesticide stakeholders are less well established and weak compared with the pesticide stakeholders. Although the pesticide community exists in a contested state, the relationship between industry and the regulator is well established. Research found that some public interest NGOs, farmers and academics were concerned that bio-pesticides are seen as merely a replacement for synthetic pesticides, rather than in conjunction with non-chemical pest control and as part of a holistic bio-rational approach to farming.

9.5. *Summary of framework for research*

Following efforts of post-Second World War agriculture to increase yields through pest control, a dominant 'pesticide paradigm' emerged, supported by a closely knit 'policy community' of individuals with a shared framework of goals and beliefs supporting the use of synthetic pesticides. For a variety of reasons, including an increased understanding of unintended adverse effects and an evolving approach to risk analysis, this paradigm is now under serious threat. The policy community which supported it has had to expand to incorporate critics of pesticide use – forming a wider 'pesticide policy network'. The dominant pesticide paradigm is now challenged by an alternative 'ecological pest management' paradigm, but this is constrained by the entrenched status and complex procedures of the pesticide paradigm.

9.6. *Paradigm in crisis*

The synthetic pesticides policy paradigm is under stress and a broader alternative paradigm is emerging in its place. The hypothesis has been tested through answering the research questions. This will allow the conceptual framework to be refined and concluded as the final part of the research process. A reminder of the hypothesis and research questions is presented below:

The proposition of the present research that **the synthetic pesticide paradigm is under threat and that an alternative ecological pest management paradigm is emerging in its place.** This generates three key research questions:

1. **Why are pesticide approval and governance challenged by some sectors of society when pesticides are, relative to other chemicals, more widely regulated and better studied for their adverse effects?**
2. **What impact does pressure on the pesticide paradigm have on the governance of pesticides?**
3. **What are the prospects for a paradigm shift from a pesticide to ecological pest management?**

The pesticide paradigm of the 1940s was created in near ideal conditions, especially when compared with the present situation. This means historically that the pressure on the policy has increased and is at the crux of why pesticides are controversial politically. For some critical stakeholders there are ultimately no redeeming features for synthetic pesticides. The

first step is to establish the elements that have made up the paradigm since the introduction of synthetic pesticides 60 years ago. The present research argues that a productive stakeholder policy community has developed in order to defend the original pesticide paradigm. Figure 9.1 shows how the pesticide paradigm has developed since the 1940s. These stakeholders 'occupy' the left-hand intentional pesticide cycle as outlined in Figure 5.1 (see Vol. 1, page 133). The defence has been necessary because the paradigm has come under pressure from the series of its elements.

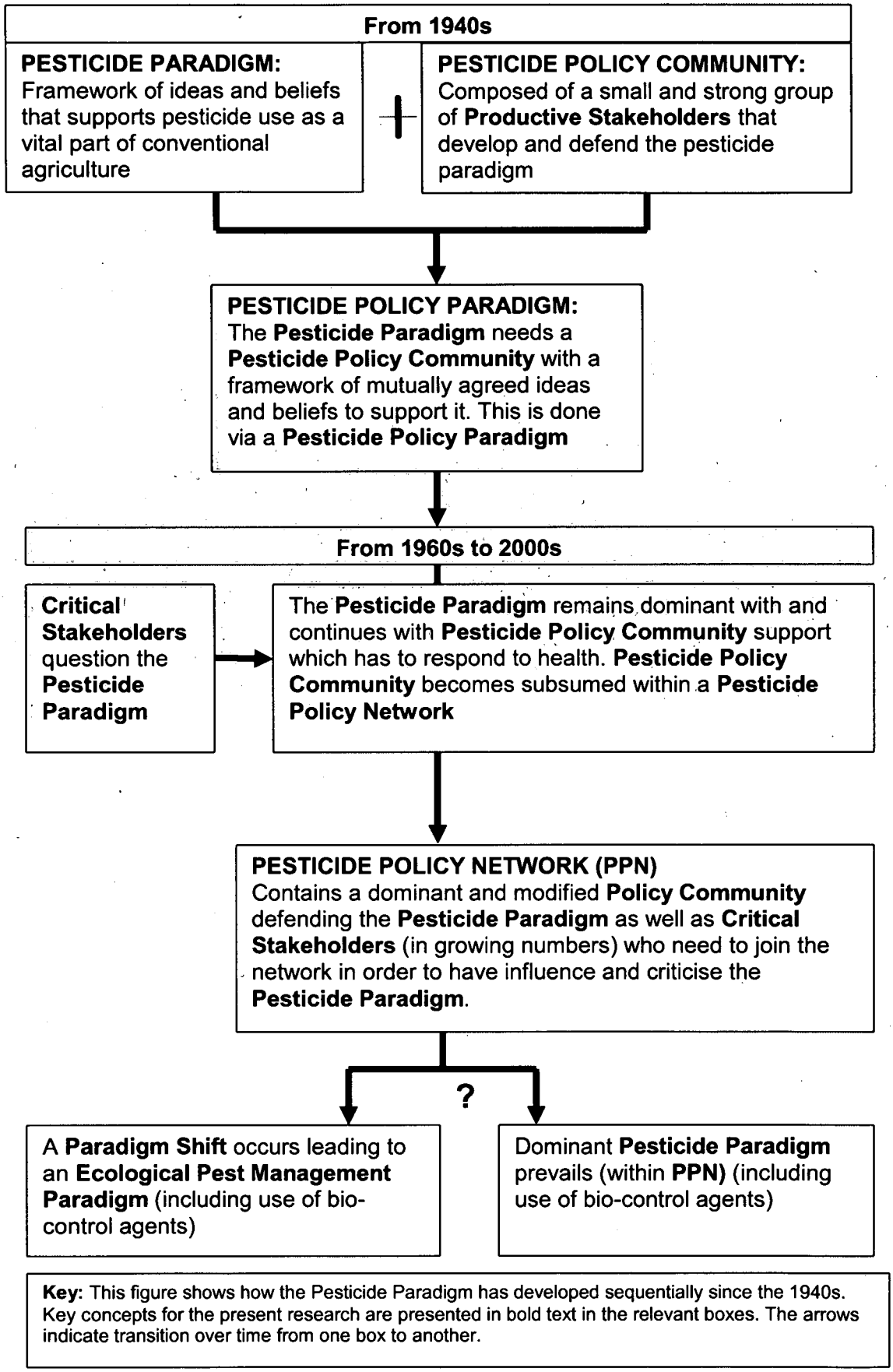
The research has identified a number of categories of pressure. These include:

- Control (voluntary and regulatory);
- Policy and stakeholder involvement
- Sustainability
- Economic and technical issues
- What are the alternatives?

Unintentional, adverse effects on human health and environment adverse effects have been experienced following the use of pesticides. This has resulted in the emergence of critical stakeholders whose primary focus is to address these problems. They 'occupy' the right-hand unintentional cycle of Figure 5.1. Their concerns persist despite the extra scientific data, regulation, and policy initiatives from the productive stakeholders supporting pesticide use.

This historical review was important because it established that the modern pesticide technological advances started at a time went the drivers for pesticide use were very different from the contemporary position in which agricultural policy is decreasing its support for production of synthetic pesticides. It set the framework by which pesticides were used and governed and included a 'pesticide policy community' that worked to a common set of ideas and beliefs to develop a 'pesticide paradigm'. This included the reasons for using pesticides, the people and organisations that developed them.

Figure 9.1 Stages in the Evolution of the Pesticide Policy Paradigm



Source: Author

The current 'pesticide policy paradigm' is very different from that of the 1940s when modern synthetic pesticides were developed. The key drivers for their development were wartime pest control needs, the need to increase food production, and security. The prevailing risk analysis model could be described then as 'technocratic', in which the scientific assessment was very closely linked with regulatory decisions. After the Second World War, this technocratic approach was mirrored by an emerging synthetic pesticide industry which helped facilitate a significant increase in the use of pesticides. The UK government oversaw a national policy that supported the development of pesticides as an integral part of conventional agriculture. The government provided the funding and foundation for research, development and regulation of pesticides. This in turn allowed for the development of the scientific expertise needed to analyse the safety and environmental impacts of pesticides. But pesticide regulation and approval occurred in secrecy. There were no external criticisms of pesticides. UK government policy recognised the need to provide pest management advice, free at the point of delivery.

Concerted research and development efforts were made in an atmosphere of limited and voluntary self-regulatory control over the approval of pesticides. The major classes of pesticides were synthesised in a matter of months, during and immediately after the Second World War. Research and development costs were low because the safety requirements were rudimentary. These requirements have since increased significantly, which has raised the costs of the development of pesticides. The fact that little information was initially available or collected was storing up problems for the future. Lessons from the adverse health and environmental effects of pesticides could not be learnt until after the pesticide had been used. In some cases, such as the chronic adverse effects, it has required decades of use before problems became apparent.

The present research proposition maintains that the original pesticide paradigm existed to protect the continued governance of synthetic pesticides in the UK and internationally. Anyone who supported intensive conventional agriculture had to support the pesticide paradigm – that is the increasingly elaborate production and scientific data on which the continued use of pesticides was justified. A key element of any paradigm is that it changes over time in an attempt to adapt to changing conditions. The pesticide policy community of productive stakeholders had to be responsive to the pressures on the pesticide paradigm. It is this support by these stakeholders as defenders of the former paradigm that has led to the creation of the current 'pesticide policy paradigm', and may evolve further evolve to the ecological pest management paradigm, as outlined in Section 9.7.

The result of this support for pesticides was the development of a vibrant pesticide industry which brought hundreds of new pesticide active ingredients onto the pesticide market, and developed into a global business.

The components of a pesticide policy paradigm are outlined in the left hand column of Table 9.1 (which has been taken from Table 4.1, Vol. 1, page 119) and compared with the situation for today.

There have been some significant policy changes over the last 60 years that have culminated in less favourable conditions for the pesticide paradigm. The UK government of the day led the development, approval and use of synthetic pesticides, in a way that would be incompatible with government policy of today. State-backed agronomic advice including pest and disease management is no longer free at the point of delivery.

At the UK level pesticide policies now include measures that attempt to reduce the environmental effects of pesticides, and minimise the pesticide residues in food. Globally accepted limits such as maximum residue limits (MRLs) support the pesticide policy paradigm because internationally agreed limits help facilitate trade. But regionally through the European Union, there are now measures which increase the pressure on the paradigm. These include the reform of the Common Agricultural Policy, EU Directives and policies on pesticides. These policies are now aimed at defending the paradigm under stress, rather than, as previously, allowing an increase in pesticide use in a situation where the paradigm was under less stress. At the same time, the food supply system is still largely dependent on pesticides, although there is a decline in the numbers of pesticides available on the EU market, and this is set to continue.

Today, there is a greater acknowledgement of the health and environmental effects of pesticides, and a demand for sustainable and ecological approaches. The UK government and pesticide industry were slow to recognise the unintentional effects of pesticides. This could be because acknowledgement threatened the pesticide policy paradigm. As a result they were slow to react. This led to the development of critical stakeholders who had different policy perspectives, such as public interest agenda that was focussed on 'health and environment' rather than agricultural 'production' and the defence of pesticide use. The entrance of stakeholders with this perspective changed the nature of the developing

Table 9.1: UK pesticide policy paradigm 1940s and today

1940/50s pesticide policy paradigm	Corresponding current paradigm
1. **War, food security** and **increased production** were key drivers for pesticide development	Support for food production decreasing through **reform of Common Agricultural Policy**
2. Policy controlled at the **national level** by central government	Agricultural policy controlled at **European Union** and **globally** through WTO
3. Government support for pesticide-related research and **free** point-of-delivery **agronomic advice** on pest and disease management	Support for pesticide research diminishing, and **agronomic advice privatised**
4. Development of a food supply economy that was **dependent on pesticides**	Food supply still dependent on pesticides; but challenged by **low in put systems**
5. Growth of **marketable pesticides** with powerful effects, long shelf life, quick results, are easy-to-use and effective against many pests in diverse locations	**Decline** in the number of new pesticides entering pesticide paradigm
6. Establishment of a small, closed, strong, professional and mutually reinforcing group of policy network stakeholders governed by **voluntary agreements;** in era of **secrecy**	Broad and diverse policy network, including **opposed** views; EU **legislation increasing;** and **improving transparency**
7. Emphasis on research and development of **active ingredient** efficacy on crops, with high potential for economic return	**Shift of government focus** to reduce pesticide impacts; whilst pesticide industry retains chemical focus
8. **Scant** consideration for long term **sustainability** of pesticides including little questioning of adverse health & environmental effects and pest resistance	**Greater** acknowledgement of health and environmental effects of pesticides, and need for **sustainable/ecological approaches**
9. **Policy segmented** by industry sectors and government departments	Policy still **segmented** nationally; and now additionally at regional (EU level).
10. Requires a **pro-pesticide defence** of the policy, including scientific 'peer review'	**Fewer** stakeholders with **defending pro pesticide stance**; scientific support divided
11. Opportunities for post-war development of a **global pesticide industry** (largely supplied by UK companies)	UK pesticide industry now dependent on foreign companies

'pesticide policy network'. It still contained a regulatory element that was stable, relatively insular and morally 'resource dependent'. Here, the same actors of the network dominate decision-making (the regulator, pesticide industry, and independent experts). Where there has been some change is with the diversity of expert opinion, and with the advent of the European Union. Here the role of the EU, EFSA, and Member State regulators have reduced the stability of the regulatory element within the pesticide policy network. The 'inverted decisionist approach' (see Vol. 1, page 38) of EU risk analysis has meant that the stability and insularity have changed. There are opportunities for the insularity to be 'breached' and for outsider stakeholders to enter the regulatory debate when regulation is debated and established within the European Union. Debate at the EU level primarily includes the pesticide industry, public interest groups, and the farming lobby. Once set, the regulatory process attempts to exclude these stakeholders, and the resource dependency between the regulator/pesticide industry/food supply chain becomes apparent because of the mutual need for pesticide approval, use and development. If unimpeded, this resource dependency reduces pressure on the paradigm and pesticides become available for use.

In conclusion, all but one of the 10 examples in Table 9.1, include policy changes which have increased the pressure on the pesticide policy paradigm. In the 1940s, there were virtually no controls over the use of pesticides and conditions were favourable for the paradigm because the pressure on it was slight. Since then there has been a succession of policy, regulatory and stakeholder changes that were designed to reduce and accommodate the health and environmental effects of pesticides.

The impact of the measures has been to increase pressure on the pesticide policy paradigm to a much greater extent than before. The pesticide policy paradigm is facing failure. One reason it has not failed is because a comprehensive alternative is not to hand. However organic farming is still relatively limited and bio-pesticides are not a comprehensive alternative, unless developing within a new agricultural approach. It could be therefore the only thing stopping collapse of the pesticide policy paradigm is the absence of any perception of a viable alternative.

9.7. *An emerging alternative*

This section examines how an alternative paradigm might fare, if the pesticide paradigm failed? The structure of an ecological pest management paradigm would be fundamentally different from that of a pesticide policy paradigm. Firstly, the present research suggests the creation of a new regulator called the Sustainable Agricultural Advisory Service which would replace the Pesticide Safety Directorate. This would mean that the regulator would be charged with finding sustainable solutions to pest management problems rather than simply approving pesticides. This would result in less dependency on chemicals, reducing the need for an expensive regulatory bureaucracy. The institutional framework would change fundamentally. New staff, or re-training of existing staff, would be needed with an expertise in non-chemical pest management.

The Sustainable Agricultural Advisory Service (SAAS) would have central responsibility for a National Pest Management Policy. The SAAS remit would be to deliver free advice on reducing diffuse pollution that could potentially cause harm to human health and/or the environment. Advice would also include promoting alternative products and farming systems approaches. This would include government funding for near-market research if it can be demonstrated that the pest management options are safer and more sustainable than existing techniques. The emphasis would be on delivery. This could take the form of supporting grower co-operatives through a Pest Management Awards innovation scheme. The regulatory procedures for any products developed through such research would be fast-tracked so long as improved safety can be guaranteed. There would be education and knowledge transfer systems for those who carry out professional pest management, as a part of their business or organisational responsibilities. This might include technically complicated pest management procedures requiring new skills. The SAAS would be obliged to link pest management policy with wider sustainability initiatives around farming systems. This would include, for example, pest forecasting, and recommendations for pest control only when needed, rather than allowing prophylactic use of chemical inputs. It could also, for example, recommend integrated pollution control co-ordination around water catchments. Measures to control pesticide pollution would not have any unintended outcomes for other potential diffuse pollution, such as fertiliser usage.

The SAAS would be accountable to a wide Stakeholder Board which would exclude membership for any organisation that has a direct financial link with pesticides/bio-pesticides. The Board would include nominated representatives from civil society, both expert and lay, along the lines of Irwin's (1995) 'citizen science'. This could also provide a

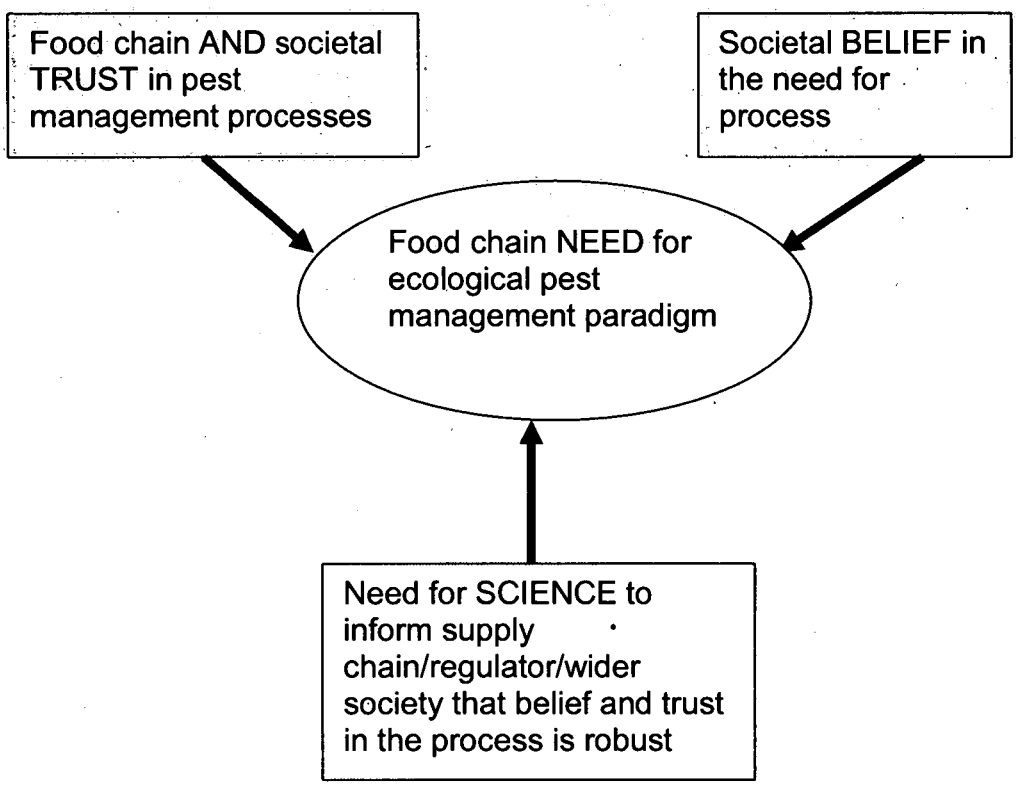
framework in which previous democratic deficiencies are accommodated. Ministers from the Department of Health would be responsible for SAAS in the House of Commons. The SAAS would be responsible for agreeing the policy principles. Approvals of bio-control products, pesticides and other pest management techniques would be the responsibility of an Advisory Committee on Pest Management (ACPM). Reporting to the ACPM would be advisory committees on health and environmental matters for a) non-chemical control, and b) chemical control, c) bio-pesticides, and d) systems approaches to pest control. In general terms, the Stakeholder Board would set policy objectives that included the precautionary principle objectives of transparency, openness, stakeholder involvement, substitution, comparative risk assessment, and measures to reduce pesticide use. This includes the co-evolutionary risk analysis model. The board would be chaired by a Minister at the Department of Health, with major decisions being voted upon. The Minister would not have the power of veto. The ACPM would be responsible for approvals, and be directed by SAAS Board policy guidelines. The committee would hold its meetings in private, with full minutes published. This would allow frank discussion among committee members, in the same way that policy discussions between ministers and civil servants are considered confidential. Members of the SAAS could attend ACPM meetings as observers.

Ecological pest management needs to have a local focus. Regional and global solutions do not work in the same way as they do for the pesticide paradigm. The focus of this approach would be nationally based. Approval of pesticide active ingredients would still come under the EU Directive 91/414 and bio-pesticides would come under national control. All other measures would come under the National Pest Management Strategy funded through national and EU (CAP reform) measures. The current bio-control agent network is economically and politically weak, and confined within the pesticide policy paradigm. This could present a drawback for a shift to an Ecological Pest Management Paradigm. This means that the required norms and beliefs around the holistic approach of the new paradigm would have to be strengthened. For this to occur, the 'strategic niche management' concept, described by Kemp et al. (1998) could provide a useful way of providing space for an ecological pest management approach to complete and ultimately deliver a more sustainable agriculture. This would include all the regulatory, policy and agronomic elements described above that would need to adapt to the different requirements of the economic, social and environmental impacts and possible benefits of the alternative paradigm.

A central integrated policy community of food supply chain, government and research expertise would need to be fostered, with a civil society that supports, believes in and trusts the principles of the Ecological Pest Management Paradigm. The need for science to inform

the process is clear, but it has to be accompanied by the extra components of a wider civil society belief in the need for such an approach and trust in those developing it, as outlined in Figure 9.2. Once the principles the paradigm are agreed, the technical science-based processes required to support the paradigm would then be more likely to receive wider acceptance. Delivering this would be the main task of the ACPM. If the need for the new paradigm is universally agreed there will be a relative tolerance to risks that are always inherent within any agricultural approach.

Figure 9.2: Requirements for an ecological pest management paradigm



Key: The three requirements (Science, Trust and Belief) are presented in the boxes around the central oval shape that represents in simple terms the needs for a successful ecological pest management paradigm. The arrows indicate that the need is required equally from all three boxes in total

Source: Author

9.8. *Links between pesticides and wider policy*

Pesticides are unique in that they are developed, regulated, used and viewed by society in a particular way. This section draws on the ways in which agricultural pesticides overlap with other similar technologies such as genetically modified food, veterinary medicines, pharmaceuticals and non-pesticide chemical contaminants of food, such as dioxins. A comparison of the technologies can be accomplished by comparing the origins, regulation, policy, governance, use and wider-societal concerns in terms of the research analysis on paradigms, risk analysis and policy networks. The list below provides a list of some technologies that could be compared with agricultural pesticides.

- Non-agricultural use of pesticides
- Fertilisers
- Pharmaceuticals
- Chemicals
- GM

One way to compare them is to consider whether there are similar characteristics in relation to paradigms. There is a link to 'technological paradigms. Although there is not complete overlap, these technologies were all developed by companies that were also selling pesticides. The pesticide industry developed in the 1940s for as much of a public health as for that of an agricultural need (see Section 4.4). There are similarities with the research and development of pesticides, often large multinational chemical companies developed pesticides as one sector within a wider chemical portfolio. They could be considered as related technology clusters in which pre-registration/authorisation trials data are required. Indeed the present research is arguing that GM is a progression along the same pesticide technological trajectory and therefore linked to the pesticide policy paradigm.

Most non-agricultural pesticides are covered by different regulations (such as biocides, veterinary medicines and human medicines) and controlled by different branches or departments of the regulatory process. The degree of need is important. On the one hand there is the public health use of chemicals to control diseases such as malaria. On the other hand there is the 'cosmetic' use of herbicides for weed control in urban parks and gardens. This particular use is being banned in Canada and is considered (by local authorities) as separate from agricultural pesticides where the same wide-spread restriction (that may include exactly the same chemicals) are not banned. Here the perceived need for pesticides determines whether use continues or not.

Synthetic pesticides and fertilisers are key inputs that sustain conventional agriculture. Many of the early pesticide companies also produced fertilisers. But post-world war two it became clear that the supply chain requirements for the two were different. Synthetic fertilisers have relatively simple chemical structures. Unlike pesticides there are only a few varieties, compared with the thousands of pesticide products with different toxic effects. The regulatory structures and policy network for pesticides are very different for that of fertilisers. There is also little pre-market testing for fertilisers compared with that for pesticides and for pharmaceuticals. For pharmaceuticals, the policy network is different compared with pesticides, because the perceived benefit is for the patient, rather than the food supply chain for the case of pesticides.

There are similarities in the way that general chemical regulation has developed through the EU REACH Regulation (see Vol. 1, page 223). Historically there has been little requirement for pre-market testing of chemicals, compared with pesticides. But the REACH, regulation has changed this situation with the implementation of the precautionary principle, and the adoption of the substitution (hazard-based approach) to risk analysis.

Risk analysis comparisons can be made between pesticides and other similar technologies. This relates to food safety, occupational and residential exposure and environmental pollution: the industry takes a risk and benefit for food safety. For pesticides the rhetoric is for risk analysis in isolation, without considering the benefits. In fact the productive stakeholders are focussed on the benefits which drive the developments and then consider the risks within the constraints of regulatory science. The benefit being economic food production compared with assessment likely side effects to human health or the environment. The critical stakeholders focus largely on the risks.

There are similarities between the GM policy network and that of pesticides. They are fundamental opponents. The resource dependence profile for the two is similar. Many of what may be considered critical stakeholders (NGOs) for GM are also critical stakeholders for pesticides. The similarity also lies in the fact that the present research considers GM and pesticide technology to be on the same paradigm trajectory.

In the UK pesticide policy has traditionally be overseen by agricultural policy (historically through MAFF and now DEFRA) rather than food policy, environmental policy and/or health policy. The relative weakness in terms of governmental food policy is reflected in the fact that the Food Standards Agency is not the lead agency in the UK. It has only a shared

responsibility for policy in relation pesticide residues in food, a contentious issue for the general public. The difficulty for such an agency is to demonstrate the agronomic competence that has always pervaded the UK policy for pesticides. This compares with the EU, where the European Food Safety Authority has responsibility for risk assessment, and DG Sanco for risk management of pesticides. This links back to the risk debate in which the EU is leading on hazard-based approach for pesticides rather than the UK, where there is more emphasis on technocratic risk assessment. This are also links between a hazard-based approach for pesticides and other EU regulation which has the same approach – such as REACH for general chemical regulation.

9.9. The usefulness of concepts included in the research

The following section discusses the usefulness of the concepts used in the present research. Essentially the assumptions made in Chapter Two (see Tables 2.1-5) hold after analysis of the subsequent data collected, although there are some reflections which are presented below.

The paradigm concept provides a framework for analysing pesticide policy. The risk analysis framework sets out the toolkit options from which the rules and decisions for the use of pesticides are made. A policy network provides characterisation of the political milieu in which pesticide stakeholders operate.

The term 'paradigm' is a useful concept for helping to understand the characteristics and evolution of pesticide policy, but there are some limitations. The following section addresses the value of the pesticide policy paradigm for stakeholders, how it does in effect help with policy-making and decision-making – that the 'control of pesticides' is as important as the control of pests.

The paradigm helps the research process to identify the decision-making processes for the continuance of pesticides. For critical stakeholders it helps to provide an outline and explain in an inter-linked way what is going on within an otherwise relatively obscure and opaque policy community. The boundaries of the pesticide policy paradigm are blurred; this is because pesticide policy is cross-cutting and overlaps across many other different areas of policy such as health, agriculture, food and environment. The present research has focussed primarily on agricultural pesticides, but many of the same chemical active ingredients are used in wider contexts (such as in homes, for veterinary and human medicinal uses). The production and use of pesticides is subject to regulation, from the perspective of an individual pesticide that has been developed from the pesticide industry. But many of the

policies that dictate which pesticides are used, when, where and why they are used is not explicitly set out in legislation. Pesticide use is influenced by wider agricultural policies such as the EU Common Agricultural Policy or the vagaries of the private sector food supply demands. The parameters that control use at a macro-economic level are in turn subject to wider agronomic considerations; what crops are grown will have a bearing on which pesticides are subsequently used. Pesticide use is also influenced by which pests happen to occur at any one time. The present research has taken the view that the paradigm boundaries include both the intentional and unintentional use of pesticides which presents difficulties when defining the limit of the paradigm.

Despite the imprecision of the concept of a paradigm, and its application to pesticides for the present research, the concept nevertheless has strong policy/political utilities. The core of the paradigm is useful in addressing the crux of the matter. For all stakeholders, productive and critical, there is considerable pressure to stay within the paradigm within the dominant notion – that no pesticides = not enough food, as developed in the starting assumptions for the conceptual framework in Chapter Two. The present research maintains that this equation is holding to a lesser degree. It is a difficult but not impossible argument to counter. Given the serious threats to the paradigm, it is all the more important that the possible demise of the pesticide policy paradigm is considered now before it is too late and whilst there is still time to implement and alternative paradigm. Currently the ecological pest management paradigm is weak and subject to powerful voices arguing for the *status quo*. A paradigm shift may under those conditions take years to occur, given the entrenched views within the food supply chain supporting the use of pesticides. The researcher is aware, through the process of this research, of actors in the food supply chain who see the provision of safer pest management alternatives as an opportunity, rather than the conventional 'oh dear, the sky is going to fall down' sort of attitude.

Risk analysis which is carried out within the pesticide policy paradigm is akin to a gate-keeping process which allows pesticides onto the market. That is where considerable power lies. Pesticides risk analysis is awash with technical data but it is overlapped with the notion from productive stakeholders of the essential need for pesticides and their paradigm. The gatekeepers use 'essential need' for pesticides like a 'golden share' that frames the argument about pesticide safety. In essence, the actual argument from productive stakeholders in favour of the orthodox paradigm is about the risk and benefits from pesticides, but how could the two be compared if the debate is apparently only about risk? In official terms, the UK regulator rhetorically operates in terms of 'risk assessment' when in fact it carries out risk/benefit assessments. The underlying issue of the fundamental need for pesticides

complicates the pesticide risk debate. It is not just a case of: 'are pesticides safe or not?' but 'are they needed in the first place?' More and more stakeholders are raising this latter fundamental question which therefore undermines the pesticide policy paradigm. The present research suggests that the disquiet has occurred because two different questions are being asked. The critical stakeholders are asking about 'need', and the policy community are asking about 'safety and efficacy'.

Furthermore, there are also two different questions in relation to safety which creates even more disunity. The pesticide policy community assesses and uses pesticide on an individual chemical product basis, whereas the wider civil society wants to know if pesticides (in all their diffuse forms) are safe. This research draws on evidence to suggest that collectively they are not. The pesticide policy community has consistently played down the unintentional impacts of pesticides from the 1940s to the present day. These understatements have led to a wider civil society lack of trust and belief in pesticides and, in effect, what the present research has termed the pesticide policy paradigm.

Policy network theory is useful for analysing the characteristics and evolution of the pesticides paradigm because it helps identify the political dynamics between the stakeholders. The pesticide policy network is now increasingly unstable because of the critical stakeholders; actors with different objectives increasingly have access to the policy network, just as long as they are not fundamentally and explicitly hostile to the pesticide paradigm. Policy networks and paradigms are useful analytical concepts because they highlight key features of the evolution of the pesticides paradigm and the responses when shared beliefs (within the pesticide policy paradigm) are criticised. In this sense policy network locates the two factions, productive stakeholders and critical stakeholders, within the same un-easy network.

9.10. Institutional responses

The main question raised in the present research: is the UK changing from a pesticides paradigm to an ecological pest management paradigm?

The proposition of this research thesis is that there is a dominant pesticide policy paradigm which is challenged and under threat. At the same time another ecological paradigm is emerging, albeit under stress because it is constrained by the dominance of the pesticide policy paradigm.

Pesticides have been very successful in killing pests, but have correspondingly strong side effects, both on human health, wildlife and the environment. After dramatic increases in pesticide use up to the mid-1990s, levels of production and sales have flattened out. At the same time the availability of pesticides is declining as the number of global production companies operating is now down from the 12 which existed 15 years ago to six. Some pesticides are being de-registered through a dual regulatory process at the UK and European Union levels.

The present research suggests that the pesticide paradigm has produced a series of failures which, acting together, will prove fatal for the paradigm. The main cause for this is the erosion of trust in society to support the beliefs on which paradigm is based. This has led to regulatory failure, where the cost of regulating pesticides exceeds the financial return to the company. The few companies that have the resources to register a pesticide have had to develop large regulatory departments that specialise in product approval. In the UK a large regulatory agency has been constructed to oversee the registration applications, which relies partly on the pesticide industry to fund its work. Eventually the consequences of regulatory failure must lead to market failure, when the cost of regulating pesticides across all companies proves excessive. At this point the paradigm fails.

The threat to the pesticide paradigm comes from regulatory failure posed by the high costs of pesticide approval and registration. The few companies that have the resources to register a pesticide have had to develop large regulatory affairs departments that specialise in product approval. In the UK a large regulatory agency has been constructed to oversee the registration applications, which relies partly on the pesticide industry to fund its work.

The pesticide approval process has been under stress to adopt an increasingly more precautionary approach since the early 1950s. Compared with other chemicals, pesticides are relatively well researched and understood, and government and independent experts have until recently given repeated assurances of safety. However an increasingly sceptical civil society is not reassured. The risks posed by pesticides are difficult to quantify, only a small community of industry/government/academic experts understand the mechanisms of pesticide risk assessment. Their technocratic model of policy making has also failed to convince civil society, and some parts of the food chain (food retailers). This is because the UK has resisted following a decisionist or co-evolutionary model of pesticide registration which includes the social, political and cultural contexts of policy making. The technocratic model has been challenged by civil society groups for many years. In the last few years, it has also been challenged by the Royal Commission on Environmental Pollution and some

members of the expert Advisory Committee on Pesticides. The reason why the risk of pesticides is being questioned is because of uncertainty with the science. Another unrecognised reason is because the key players in the pesticide policy process (government and industry) are failing to tackle the social science issues raised by pesticide use as outlined in this paper. As an acknowledgement of this process there is a shifting of power within the food supply chain that relates to pesticides. Some food retailers are taking on a governance role by developing their own progressive pesticide policies.

Bio-pesticides are being regulated through the Pesticide Safety Directorate as synthetic pesticides. This represents a 'first order' paradigm change [as outlined by Hall, (1993)] in which these products are treated in the same pesticide policy paradigm. These alternatives have to go through the pesticide paradigm approval which is proving a barrier to their useful development. The present research further suggests that a 'third order' paradigm shift will be essential to provide a viable ecological pest management paradigm. Elements of an ecological pest management paradigm are already emerging, but they are still constrained by a failing pesticide policy paradigm.

Thus the implications are that:

- There is a synthetic pesticide paradigm which is becoming increasingly unsustainable
- Bio-pesticide alternatives are emerging but are subject to regulatory failure and market failure. In addition the potential for social failure is unknown.
- Bio-pesticides are being forced down a pesticides paradigm route whilst the conditions are in place for a paradigm shift towards ecological pest management

9.11. Reflections and implications for the future

Some constraints were noted in terms of research methodology. The 'saturation level' was not reached for interviews, because of lack of time and resources. This is because the pesticide policy network has many sub-groups, and there are many different pre-determined points of view. Even so, a large proportion of the research time was taken up with the interviews. A questionnaire, in addition to the semi-structured interviews would have provided additional useful information, again if time and resources had permitted.

In terms of subject matter content, genetic modification (GM) is not considered. This is because pest control related-GM research and development technology has been very limited in the UK during the present study period. In addition, organic farming, although mentioned, was not analysed in a great detail.

Having characterised a pesticide policy paradigm, further research could use the paradigm presented as a template for further refinement by gauging feedback from the network of stakeholders. It has been acknowledged that the term 'pesticide paradigm' is little used, or 'pesticide policy paradigm' which has been derived from the present research, and yet it are a central factor controlling pesticide use. Future research could present the characteristics of the pesticide paradigm as a scenario to stakeholders for elucidation and discussion.

The ecological pest management model is not well established in the literature. Further research could usefully be employed investigating how such a model could be developed to describe how it might relate to sustainable agriculture. There is little current knowledge about how the general public would respond to the wide spread use of bio-pesticides. Qualitative and quantitative social research would be welcome to elucidate consumer views of bio-pesticides and risk assessment. This could include closed-end surveying, and more detailed focus group analysis. Finally a citizens' jury-type of process would allow a relatively unknown technology to be discussed and scrutinised in a more systematic manner. What are the implications of climate change; will pest and disease will become more common as a result?

Another area of research could involve examining the impacts of a draft EU regulation covering pesticide authorisation (PSD, 2008c). As a replacement for the existing Directive 91/414, it will have to be implemented directly into Member State law, rather than being subject to national legislative interpretation. Various forms of the draft regulation have been debated by the European Commission, European Parliament, European Council, Member States governments and other stakeholders, and a final outcome could be forthcoming over the next few months. This regulation has the potential to remove more pesticide active ingredients from the European market, compared with the current Directive. This would be achieved through the provision of progressive measures such as the adoption of hazard 'cut off criteria' and the 'substitution principle'. According to the European Commission, proposals from the European Parliament could result in 85% of the pesticides authorised for use in the EU being banned. The Pesticide Safety Directorate (PSD) has interpreted this to mean that these proposals would make conventional commercial agriculture in the UK unachievable, as it is currently practised (PSD, 2008a). Future research could explore the

many different stakeholder views concerning the precautionary nature of this regulation. Such research would deliver useful empirical data covering the 'risk analysis' and 'policy network' aspects of the pesticide paradigm, as adopted in the UK and EU.

Synthetic pesticides face many challenges, as outlined in the present research. In the future, oil-based fossil fuels, the raw material on which pesticides are based, are likely to become increasingly expensive, and will eventually run out. For all these reasons there is a need to research and develop alternative methods of pest and disease management. The pesticide industry is developing GM technology as one solution – but this has proved controversial with wider civil society and elements of the food supply chain, notable multiple food retailers. This biotech response has stalled in the UK; and is at odds with an ecological pest management paradigm. Future research could examine how these competing solutions have developed. Specifically this could be done through establishing and comparing sustainability criteria for integrated crop management, which allows the use of synthetic pesticides and (in theory) GM technology with organic farming, with its holistic approach that seeks to avoid such technologies.

Thesis overview:

The proposition of the present research is that in the efforts of post-Second World War agriculture to increase yields through pest control, a dominant 'pesticide policy paradigm' has emerged, supported by a closely knit 'policy community' of individuals with a shared framework of goals and beliefs supporting the use of synthetic pesticides. For a variety of reasons, including an increased understanding of unintended adverse effects and an evolving approach to risk analysis, this paradigm is now under serious threat. The policy community which supported it has had to expand to incorporate critics of pesticide use – forming a wider 'pesticide policy network'. The dominant pesticide paradigm is now challenged by an alternative 'ecological pest management paradigm', but this is constrained by the entrenched status and complex procedures of the pesticide paradigm.

Annex 1: Actors in the contemporary UK/EU pesticide world

1. Production

Synthetic pesticide industry

- UK Crop Protection Agency
- European Crop Protection Agency
- Crop Life International (Global)

Major companies

- Syngenta (Swiss)
- Monsanto (US)
- Dow (US)
- Bayer (German)
- BASF (German)
- Du Pont (US)

2. Bio-pesticides/alternatives industry

- International Biological Control Manufacturers Association (IBMA)

3. Control (regulation and monitoring)

UK Regulator

- Pesticide Safety Directorate/DEFRA

Other government departments

- Health and Safety Executive
- Food Standards Agency
- Environmental Agency
- English Nature
- Department of Health
- Health Protection Agency
- Devolved Administrations

EU Regulator: (Risk Management)

- DG Health and Consumer Protection
- DG Environment

(Risk Assessment)

- European Food Safety Agency

UK – main sources of expert advice

- Advisory Committee on Pesticides
- Biocides Consultative Committee
- Pesticide Residues Committee

EU – main sources of expert advice:

- Scientific Panel on Plant Protection Products and Their Residues

Global

- International residue limits and toxicological standards FAO/WHO Joint Committee (Codex)
- OECD guidelines on data requirements for pesticides and bio-pesticides

4. Pest management advice

- Private (such as – Agricultural Development and Advice Service (ADAS)
- Public academic research (such as CABI provides scientific advice on pest management)

5. Primary Food Producers

- Farming organisations (National Farmers Union)
- Suppliers

6. Primary Food Distributors

- Multiple food retailers (Tesco, ASDA, J Sainsbury, Marks and Spencer)
- Suppliers

7. Citizens/unions/public interest

- Pesticide Action Network UK
- Pesticide Action Network Europe
- UK Pesticides Campaign
- Friends of the Earth
- Royal Society for the Protection of Birds
- National Consumer Council
- Transport and General Workers Union

Glossary of terms

Acaricide: Type of **pesticide** designed to kill or control species of the Class Arachnida (mostly includes mites).

Acceptable daily intake (ADI): Amount of pesticide residue in food or drinking water that can be taken orally over a life time without appreciable health risk (measured in mg of pesticide per kg of body weight per day). ADI are estimated for individual pesticide residues and are largely based on extrapolation from long term animal studies. They usually incorporate uncertainty factors that typically include x10 to take into account difference between test species and humans, and a further x10 because of sensitivity among humans. The ADI is assumed to relate to a healthy adult of normal weight who consumes an average amount of the particular pesticide residue. (See also **acute reference dose**).

Active ingredient: Chemical (or biological agent) of the pesticide formulation that is designed to carry out the pesticidal activity. The remainder of the formulation composes inert ingredients, not designed to be toxic, that assist in the delivery of a pesticide.

Adverse effect: A treatment-related alteration from the baseline that diminishes an organism's ability to survive, reproduce, or adapt to the environment.

Acute reference dose: Amount of pesticide residue in food or drinking water that can be consumed in a short period of time (e.g. one meal/one day) without appreciable health risk. It is normally derived by applying an appropriate uncertainty factor to the studies that assess acute toxicity or developmental toxicity (see also **acceptable daily intake**).

Agrichemicals (also known as 'agrochemicals'): Includes the external agricultural inputs pesticides and fertilisers, although there is confusion with the usage of both 'agrichemical' and 'agrochemicals'. The terms can also be used to refer pesticides on their own as in the case of 'British Agrochemical Association' whereby the industry organisation lobbied solely for pesticides.

Amenity use: Pesticides used by local authorities to control weeds on roads and in parks, schools and other institutions. It is one example of non-agricultural use of pesticides.

Assurance schemes: The voluntary farm assurance schemes ensure food producer members cover a range of standards including safety, welfare and the environment. Food producers join the schemes in order to assure customers that these standards have been met. Examples include: the Red Tractor; Royal Society for the Protection of Animals – Freedom Food; LEAF Marque (Linking the Environment and Farming); and the Soil Association organic standard.

Biocide: Pesticides that are used in the non-agricultural sector, (defined under European Union Directive 98/8).

Bio-control agent: is a generic term to describe as biologically based pest control products, derived from or consisting of living organisms. Four sub-groups include: 1) Plant-based chemicals such as garlic and mint oils; 2) Semio-chemicals such as **pheromones**; 3) Microbials such as viruses and bacteria and fungi; 4) Invertebrate bio-controls such as nematodes and insects. See also **Bio-pesticide** which is defined in UK and EU law excludes the 4th Bio-control agent group.

Bio-rational approach: a method of adopting pest management that works with natural processes to control pests in a sustainable way that minimises the risks to human health and the environment.

Bio-pesticide: Defined in UK and EU law as biologically based pest control products, derived from or consisting of living organisms. Three sub-groups include: 1) plant-based chemicals such as garlic and mint oils; 2) semio-chemicals such as **pheromones**; 3) microbials such as viruses and bacteria and fungi. The UK and EU excludes invertebrate bio-controls such as

nematodes and insects from the Bio-pesticides category. **Bio-control agent** is the generic term used by the industry lobby organisation International Bio-control Manufacturers Association to describe bio-pesticides and invertebrate bio controls.

Civil society: Represents collective action around shared interests, purposes and values, and, in theory, is distinct from the state, family and business. It includes organisations such as registered charities, consumer/environment/development nongovernmental organisations, community groups, professional bodies, trades unions, self help groups and business associations.

Cancer: The general term for a group of diseases which arise following change in a single cell or local group of cells, resulting in abnormal rates of cell growth, differentiation and cell division. The primary disease spreads because abnormal cells invade, disrupt and destroy the architecture of surrounding normal tissues. They also invade and spread via blood and lymphatic vessels forming 'metastases' which become new centres of growth (commonly situated in bone marrow, live and lungs). Some main cancer groups affect organs in the body such as the lungs, breasts, liver, testes, ovaries, and nervous system.

Coding: Occurs in qualitative research whereby data are broken down into component parts and labelled as common sub-groups.

Conventional farming: Industrialised agricultural system characterised by mechanisation and monocultures, with an emphasis on productivity and profitability. It relies inextricably on external inputs such as synthetic pesticides and fertilisers.

Cosmetic use of pesticides: Includes usage designed only to improve the appearance of agricultural produce, rather than have a direct pest and/or disease management function. The term is also used to describe pesticides used in some urban settings, such as weed control in parks and gardens.

Deductive: Social science research carried out with reference to theory. See also **Inductive**

Diffuse pollution (also known as non-point source pollution): Arises from the dispersal of pesticides applied from multiple sources. Diffuse sources are often individually minor, but collectively significant, and can involve the same or a mixture of pesticides. Pesticides can enter water courses from spray drift which can affect hedge rows and other areas in the vicinity of spray applications.

Ecological fallacy: Involves the identification of statistical relationships at the aggregate level that do not accurately reflect the corresponding relationship at the individual level.

Ecological pest management paradigm: embraces a bio-rational approach which has been defined as a way of pest management that works with natural processes to control pests in a fashion that minimises risks to human health and the environment. Such an approach would also have to include a mechanism that allowed for the comparative assessment, making sure that the pest management solutions adopted are the safest options available.

Endocrine disruptor: Chemical substances that mimics or disrupt hormone activity. They have been linked to adverse biological effects in animals, and low level exposure may cause similar effects in humans. Endocrine disruptors can include some environmental pesticide residues.

Exocrine disruptor: Chemical substances that mimic or disrupt **pheromone** activity.

EU Directive: EU legislation, that is less binding than an **EU Regulation**. It has to be transposed into national law, which allows for some flexibility to national governments.

EU Regulation: Is directly applicable within the Member State once published by the EU institutions.

External validity: The extent to which specific results from a study relate to generic academic theoretical discourse.

External costs: When referring to pesticides, this includes negative health and environmental effects caused as a consequence of pesticide use that adversely affect third parties.

Formulation: is the form in which a pesticide product is marketed and regulated (if used legally). It contains the active ingredient, designed to kill the intended pest, and inert ingredients, not designed to be toxic, that assist the delivery and action of the active ingredient.

Fungicide: a type of **pesticide** used to kill or control fungi.

Genetic Modification: Represents a technology in which genes are manipulated to introduce new, or alter existing characteristics, or produce a new protein or enzyme.

Governance: Accepts that there are established patterns of rule without an overall ruler.

Herbicide: a type of **pesticide** used to kill or control weed species.

Human medicine: Can include a **pesticide** used to control human parasites (pests).

Individualistic fallacy: Where it is a logical error to draw conclusions about groups based on data gathered from an individual of that group.

Inductive: Theory generated from research. See also **Deductive**

Integrated farm management: There are a number of similar 'integrated' terms which are defined and used by conventional farming and its supply industry: integrated farming, integrated crop management. The emphasis is on safer and better use of pesticides, rather than using less.

Integrated pest management: IPM includes the combinations of all types of pest management techniques: chemical, biological, ecological, mechanical, cultural (such as timing of planting, and use of plant varieties). 'Ecological integrated pest management' involves largely non-chemical methods of pest control, avoiding prophylactic use of pesticides, only for use in emergency circumstances. Many definitions exist.

Leukaemia: A form of **cancer** where the white blood stem cells undergo malignant change. Unlike other cancers it is widely disseminated from the outset.

Lymphoma: The name given to a group of tumours affecting the lymph glands, most of which are malignant (see **cancer**). The classification is complex and includes the Hodgkin's and Non-Hodgkin's disease.

Maximum residue level: Maximum concentration of a pesticide residue likely to occur in food after use of pesticides according to Good Agricultural Practice. MRLs are not safety limits and residues exceeding MRLs do not necessarily imply a risk to health (see also **Acceptable Daily Intake** and **Acute Reference Dose**).

Meta-analysis: Widely used in epidemiology and evidence-based medicine. It combines the results of several studies that address a set of related research hypothesis.

Multilevel governance: Often used to describe the EU. It means a system in which power is shared between the supranational, national, and sub-national levels. The term also suggests there is a fair bit of interaction and coordination of political actors across those levels. How they interact, and with what effects helps determine the shape of European integration

Mutual recognition: Agreement across the EU for the regulatory decision of one Member States (to approval of the use of a pesticide) to be accepted in all other Member States. In the case of pesticides, there are many examples for which Mutual Recognition has failed.

Natural science: Is the study of the natural world including biology, chemistry, physics, and earth sciences. Experimentation is founded on the methodology that all the relevant variables are controlled bar the one which is the subject of research. Applied science includes the application of research through natural science techniques in relation to human technological needs.

Neo-liberalism: The economic theory which holds that the state should have little or no role in the economy, that inflation must be kept low, and that the market should be allowed a virtually free reign. It is criticised because it focuses on economic rather than political integration

Neo-institutionalism: Focuses on developing a view of institutions that examines the way they interact and the way they affect society.

Non-governmental organisation (NGO): Refers to civil society group in which the members have a common area of interest. Organisations can include public interest environmental NGOs and industry NGOs such as pesticide trade associations.

Non chemical pest control: A group of methods including cultural, mechanical, cultural control methods.

Odds ratio: is a ratio of one event occurring in one group compared with the odds of it occurring in another. An OR of 1 suggests that the event being studied is equal in both groups. An OR above 1 indicates that the event is more likely in the second group compared to the first group. OR are subject to a **confidence interval** (usually 95%) where the range of values within which (95% of the time) the true value would fall.

Organic chemicals: Refers to synthetic pesticides produced by the pesticides industry that are based on organic chemistry. They should not be confused with organic farming, or the very few chemicals which are permitted for use in organic farming.

Organic farming: Holistic form of farming that is designed to work in harmony with natural systems. Organic farmers are not allowed to use synthetic pesticides and fertilisers, genetically modified crops and livestock additives. Farming and processing methods are legally defined, according to rules set at the UK, European Union and international levels. Four (non-synthetic) chemicals are approved for pest control on a use-of-last-resort basis.

Paradigm: A pattern or example that describes a particular way of framing, defining and assigning categories, developing theories, ideas and procedures within disciplines; and during particular historical periods.

Pesticide policy paradigm: Institutionalises and develops the continued governance of pesticides within a common set of beliefs and procedures, as seen in the UK during the 1940s and 50s. It has been constructed for the present research to denote that the paradigm is highly reliant on a policy community of integrated productive stakeholders to support and justify the pesticide paradigm against the concerns of critical stakeholders. It also reflects the political nature of current pesticide policy (see Chapter Two).

Parkinson's disease: A slowly progressive and ultimately fatal neurological disease. The causation is uncertain but probably multi-factorial. It is characterised by paralysis, rigidity and tremor.

Pest: Any unwanted living organism that poses a threat to the well-being of human groups or individuals. Important examples of pests include vectors of human, animal or plant disease and species which threaten food supplies.

Pesticide: A substance that is designed to kill or to control the excessive growth or reproduction of pests. In the context of this thesis the term is usually applied to synthetic chemical agents. Pesticides are intended to kill a pest selectively without harming other living forms. This is not always the case.

Pheromone: A chemical that triggers a behavioural response in another member of the same species. See also **Bio-pesticides** and **exocrine disruptor**.

Plant protection product: Another name for **pesticides**, most used in agriculture (defined in EU Directive 91/414).

Qualitative research: Method of social science research in social science in which emphasis is placed on description and discovery. It involves the use and collection of a range of data including case studies, personal experience, interview and cultural texts.

Regulatory science: Scientific techniques that help deliver regulatory outcomes such as the approval or prohibition of pesticide active ingredients.

Risk (human health): The chance that a person may develop a particular disease. When comparing to groups the risk can be expressed as an Odds Ratio which describes the relative risk of a disease occurring.

Risk (pesticides): The risk of harm to an individual or population relates to the intrinsic hazard of a pesticide active ingredient combined with the extent of exposure to the chemical.

Risk analysis (pesticides): refers to the overall process by which risk and pesticides are governed. It can be summarised as risk analysis = risk assessment + risk management + risk communication. Although there are examples in which the risk assessment predominates and the other roles are down-played and/or obscured within the governance process. **Risk assessment** involves identifying sources of potential harm, assessing the likelihood that harm will occur and the consequences if harm does occur. **Risk management** evaluates which risks identified in the risk assessment process require management and selects and implements the plans or actions that are required to ensure that those risks are controlled. **Risk communication** involves an interactive dialogue between stakeholders and risk assessors and risk managers which actively informs the other processes.

Rodenticide: a **pesticide** used to control rodents (mostly rats and mice).

Semi-structured interview: A interviewee is asked series of general questions produced from a pre-determined Interview Guide. The interviewer is given latitude to ask further questions in response to what are seen as replies which have significance to the research being applied.

Social sciences: Academic disciplines that study how humans act within their environment. They emphasise the use of scientific method through the use of quantitative and qualitative research methods. See also **Natural Science**.

Stakeholder: A pesticide stakeholder is anyone who has an active interest in issues surrounding the production and use of pesticides. Broadly they may be divided into **productive stakeholders** who are primarily concerned with the manufacture and distribution of pesticides; and **critical stakeholders** who are primarily concerned with the risk and safety factors accompanying the use of pesticides.

Veterinary medicine: Can include a **pesticide** used to control parasites (pests) of domestic animals.

Voluntary Initiative: The VI was established in 2001 as a range of measures carried out by farmers and the supply industry to reduce the environmental impacts of pesticides. It was established by the pesticides industry as an alternative to a pesticides tax.

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