MAINTAINING THE HEALTH OF ECOSYSTEMS IN THE 21ST CENTURY: THE CHALLENGES FACING PLANT PROTECTION SCIENCES, INDUSTRY AND USERS

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INTRODUCTION

This paper aims to outline some of the challenges I perceive to be facing plant protection researchers, industry and users of products and services; challenges that are increasingly a product of ongoing globalisation of trade, increasing concerns about environmental stewardship world-wide and a decreasing trust by society of environmental management, assurances by governments, their agencies, businesses and, in some cases, of the science itself.

The origins of plant protection, as a science and an industry, lie with the protection of food and fibre crops. The focus has been on production protection with, initially, relatively little attention to the environmental impacts of most control technologies. As the science and the business of plant protection has matured over the last three or four decades, it has expanded to include recognition of the ongoing needs of production protection, its role in protecting conservation ecosystems, the environmental consequences of production protection products and the societal acceptance or rejection of the environmental impacts of these products. It is this maturing of the approach to plant protection that now presents the greatest opportunity for those working in all aspects of the field, as well as the greatest risks if the increasing complexities in the whole field of food production and protection are not fully recognised.

A global context

In global terms there is no question that one of the single biggest challenges facing humanity is going to be the maintenance of food supplies over the next 50 years as the global population rises to more than 8.5 billion. However, in a plant protection context, and particularly in terms of New Zealand's position in the world as a premium food and fibre producer, it is simplistic to focus primarily on the maintenance of production capacity. It is also essential that there be a sharp focus on the maintenance and enhancement of the environmental qualities of food- and fibre-producing agricultural ecosystems, including "down stream", on land and ocean systems that receive the wastes of our production systems.

New Zealand, as a society and an economy, has some unique challenges. These are:

- That our economic and social health is very closely tied to the maintenance of a healthy natural resource base, not just in terms of our traditional land uses for agriculture and forestry but also in terms of the expectations of an increasing number of international visitors and our predominantly urban population.
- That this natural resource base is a relatively limited one in terms of high quality soils and, increasingly, in terms of high quality water because of competing demands - particularly between urban and agricultural horticultural uses in the vicinity of our urban areas.
- That while our trading future lies largely in the more affluent world of North America, Europe and Asia, there is limited evidence that these markets are prepared to pay the full ecological cost of production. If one of our keys to wealth generation rests with the ongoing sustainable management of ecological systems, it is essential that we ultimately obtain a return for our products that fully reflects the ecological cost of production, ie, the system must be ecologically sustainable.
- For New Zealand it will increasingly be the demands of global consumers for higher

environmental management, and hence standards, that will drive our science investment and evolution of production systems. While we have some innovative environmental legislation in the form of the RMA, the Biosecurity Act and the Hazardous Substances and New Organisms Act, these Acts in themselves are only “baselines” for increasing our environmental qualities. Ultimately, most standards will have to exceed those that may be achieved by regulatory processes.

- The “bottom line” for New Zealand is simply that a key strategic advantage is our environmental quality. Its maintenance is critical in a world where it is increasingly valued as a component of food and fibre production and where recreation in pristine landscapes and on and in high quality water bodies is cherished by an increasing number of people.

Societal appreciation of the environmental challenges of plant protection

The need to introduce new plant protection products and systems is an imperative. However, societal acceptance of pesticides, chemicals, foreign organisms, resistant cultivars and genetically modified organisms is probably decreasing annually. This has enormous implications for those researching future plant protection options and those who will be investing the enormous sums of capital to bring them into use. The component that seems to be missing in the equation is consideration of all the factors that are causing the decreasing societal acceptance of some new plant protection products. Two of these factors may lie within what can be broadly described as education. On one level, societal awareness and understanding of factors affecting our natural environment and our food supplies has increased dramatically over recent decades even though the links between personal “wants” for goods and services and environmental impacts may not always be appreciated. At another, however, there has been a decrease in the level of understanding of the complex inter-relationships between the ongoing maintenance of food and fibre producing agricultural ecosystems and the choices that have to be made about the input of nutrients and materials to sustain those systems. In part, this apparent lack of appreciation of the complexity of the situation is tied up with a decreasing trust of those agencies and businesses developing and certifying products and processes needed to sustain complex production systems. This decline in trust would appear to be a product of complex perceptions of benefit and risk, issues of social inequity (in terms of perceived benefits to few and risks to many) and some spectacular examples of where government assurances of safety have been proven false, eg. the BSE debacle in Britain.

Fundamental to the future of plant protection, of both the science and the business, is the need to greatly increase understanding of the factors that influence community trust. There is a growing body of research information in this field (eg Marris and Langford 1996), most of which highlights the low levels of trust in government and industry and the relatively high levels of trust in family, close friends and environmental organisations (Fig. 1).

A study by the Parliamentary Commissioner for the Environment (Parliamentary Commissioner for the Environment, 1996), of conflict resolution needs associated with the implementation of the RMA, revealed:

“In the Parliamentary Commissioner for the Environment’s experience, environmental disputes arise when all or some of the parties involved in a decision-making situation:

- do not trust each other;
- do not have access to the fullest possible information about:
 - the decision-making process;
 - the implications and detail of proposals;
- perceive the significance and/or conclusiveness of the information differently;
- do not share the same views as to what should be done as a result of the information. These views may be based upon different beliefs and values.”

Those investing in the science and development of the 21st century plant protection products, should increasingly be focussing on the sciences of risk management and the extensive studies being done world-wide of perceptions of risk within communities (Anon. 1992).

FIGURE 1: Who do we trust?

Plant protection research is no longer just a biophysical science. This may become increasingly apparent as the Environmental Risk Management Authority implements the Hazardous Substances and New Organisms Act. At the end of the day the decisions of the Authority will not be based entirely on the quantitative physical sciences most of us are so familiar with. They will have to increasingly involve sciences of human behaviour, listen to communities and, ultimately, decide what risks and benefits the not-fully-informed consumer public is willing to accept.

The recent decision by the NZ Meat Board to exclude, from a quality assurance labelling programme, meat derived from livestock treated with growth promoters is a portent for the future. The reversal of an earlier decision to accept treated meat, within the criteria for the new quality label - a decision based largely on a traditional science view of risk - is indicative of the changes taking place in terms of what is acceptable knowledge for decision makers. The most important aspect of this example is that consumers are demanding to know what goes into the production of their food. Food quality and environmental quality labels must be explicit in terms of what they are representing. The messages here for plant protection must not be lost!

A 1994 survey of New Zealanders' understanding of environmental issues, and expectations, is enlightening in terms of the knowledge gaps and increasing demands for the maintenance of environmental qualities (Gendall *et al.* 1994). The spectrum of environmental concerns is outlined in Fig. 2. While there is a global perspective to these concerns, (eg climate change and nuclear power), pesticides and agrichemicals are certainly a major concern. However, the understanding of the impacts of these is poor as witnessed by the following quote:

"Nearly 50 percent of respondents believed that all man-made chemicals can cause cancer if you eat enough of them, and more than 30 percent thought that all pesticides and chemicals used on food crops cause cancer in humans." (Gendall and Russell 1994)

Equally important is New Zealanders' expectation of what should be done about certain environmental impacts (Fig. 3). There is a very high support for regulation and even higher costs for compliance. However, this support varies markedly depending on whether the risk is an accepted one (ie use of cars) or an imposed one such as exposure to chemicals. Where people choose to accept risks, they don't want legislative intervention, despite environmental impacts. Where they don't have a choice, they do want legislative actions.

Securing the future monitoring the impacts

Ensuring the environmental integrity of any system depends on having an appreciation of what factors are likely to affect the system in the future (assessing what is coming) and monitoring the impacts of what is being introduced into the system at the present time.

The RMA is, as most New Zealanders now appreciate, an effect-based legislative framework. If uses are to be assessed according to their effects, good monitoring is an imperative. In the case of plant protection systems, the greatest responsibility for monitoring rests with the users and developers of systems and component products, not local

FIGURE 2: New Zealanders' environmental concerns.

FIGURE 3: New Zealanders' expectations of the Government's role in environmental issues.

government or any other agency. In making this comment, I am very aware of the extensive residue monitoring that goes on, particularly in our export product sectors, and the monitoring of persistent compounds such as DDT. However, is sufficient effort going into monitoring the long-term impacts of regularly-used products?

Part of the societal concern regarding pesticides is the fact that, in some cases, it is decades before we've appreciated what the true implications of their use is. The classic example is DDT, but there are increasing concerns regarding the effect of a wide range of compounds on immune and endocrine systems (Colborn *et al.* 1996; Repetto and Baliga 1996).

The thrust of structural reforms in New Zealand over the last decade and a half have been towards self regulation and reduced government agency control. While this approach has considerable merit in terms of encouraging responsibility for the impacts of resource use, or product application, it may not deliver, overall, an acceptable level of environmental management because some individuals or businesses do not meet agreed voluntary standards. Industry monitoring of plant protection products and services, while it has improved considerably in recent years, is still an area of concern. This is evident in the management of spray drift - a concern examined by the Parliamentary Commissioner for the Environment in 1993 (Parliamentary Commissioner for the Environment 1993). There were some clear agency and user deficiencies in the system for the management of agrichemical sprays at that time. These included:

- No clear requirement for a person applying agrichemical sprays to supply information to neighbours or the community;
- No clearly identified agency that concerned individuals exposed to off-target spraying activity could contact;
- Lack of recognition by health providers of potential agrichemical exposure symptoms in people;
- Lack of effective sanctions to ensure compliance with existing regulations governing the application of agrichemical sprays.

While I believe matters have improved since 1993, my Office continues to receive expressions of concern regarding agricultural chemical spray drift, particularly in relation to aerial application. Ultimately, if political pressure to introduce much more stringent controls on plant protection products is to be avoided, industry will have to introduce systems of product supply and application which all users must comply with. A simple approach would be that any misuse of a product results in future non-supply by the importer or manufacturer.

It is acknowledged that major advances have been made in spray application training (e.g. the Spray Grow programme) and in the use of audited spray diaries in the horticultural industries. These horticulture and vegetable production initiatives are examples of what is necessary now in the arable and pastoral sectors.

Plant protection R and D: What focus for the future?

There appear to be four broad dimensions that are critical to the future evolution of plant protection science and its adoption. These are the need for:

- a clearly focused inter-disciplinary approach to research;
- an ecosystems orientation to research for production and conservation systems;
- research on societal perceptions of the environmental qualities needed to sustain food and fibre production systems and the risks associated with products used to protect those systems.
- development of decision support tools and advanced joint farmer/science co-learning programmes to increase uptake of more advanced plant protection systems.

There are clearly many elements within these four research spheres. For example, there will need to be close links between the biochemists and physiologists of the plant, insect and pathogen worlds with those with skills to synthesise species-specific products, and those capable of integrating them into ecological management systems where their fate and impacts can be assessed in the short and long term. Increasingly plant protection solutions will lie in intensive studies of the ecosystem and the best combination of options to achieve the desired outcome. Increasingly these will be a combination of plant breeding for resistance, biological and chemical management of unwanted species and

sophisticated management techniques. An integral part of this component of plant protection research will be increasing emphasis on the development of advanced decision support systems that allow pest and disease thresholds to be estimated and interventions kept to the minimum necessary to meet the desired product quality with minimal environmental impacts.

Research on societal perceptions of risk, associated with plant protection activities in New Zealand, can only be described as embryonic. While research on risk perceptions is well developed, particularly in relation to some areas of medicine, the airline business and nuclear industries, it is not well developed in terms of the expectations of food producing systems. This is a major risk for New Zealand, given the increasing demands of our affluent global consumers. This will be translated through the supermarket chains which are the primary purchasers. They will increasingly want guarantees of the environmental integrity of the production system their food is produced from. The challenges to implementing more complex plant protection systems, such as the many forms of integrated pest management (IPM), also require much more substantive study. Californian research (Sorensen 1993) has clearly shown there are some major barriers to adoption. I suspect the pip fruit industry may be going to face these barriers, in a substantive way, as market pressures to adopt the "integrated fruit management" system increase.

Ultimately the big challenges lie in the current funding system for research, one that is not well geared to multi-disciplinary research projects, social research or research associated with the development of advanced decisions support systems. For a variety of reasons, the details of which are beyond the scope of this paper, such research tends to fall through the funding net and is increasingly exposing New Zealand to the risks already outlined.

Industry orientation

In view of societal concerns regarding pesticides, clearly illustrated in the 1994 survey of New Zealanders, it is timely for the agrichemical industry to examine its marketing strategies and the profile it presents, particularly via television, to the non user public in New Zealand. It could be that substantial promotion on prime time television, while targeting the users, is also (even subliminally) raising the level of concerns among the majority of New Zealanders who are not users of pesticides. This could be an example of where a particular form of promotion (ie, television) is fuelling a societal perception. Maybe the investment would be better placed in other forms of product promotion, particularly those that focus on the benefits derived (in production and environmental terms).

The form of application of a pesticide also heightens concerns. Aerial spraying, and application of poison baits, have generated extensive concern regarding pesticides in New Zealand. In part this is due to it being a relatively uncontrolled form of application that can lead to greater non target risks, including risks to people. In the interests of reducing consumer concerns it may be timely for the plant protection industry to thoroughly review its whole promotion strategy and invest some research into people's perceptions of the promotion and application of products.

CONCLUSIONS

1. The future of plant protection, both in terms of science and product development, is inextricably linked to the requirements of our global consumers. The environmental demands of these consumers, expressed through the specifications for product and environmental qualities set by the world supermarkets, will continue to rise. Also of increasing importance are the demands and expectations of our many international visitors, visitors who frequently have high environmental management expectations and who look over the fences of our farms and observe our horticultural enterprises. Their expectations, in terms of plant protection practices, also have to be met.
2. There needs to be a greatly increased investment in societal education (not simply public relations) regarding the plant protection challenges facing our food, fibre and conservation systems in New Zealand. This education must be through the formal education systems, via the public agencies and by businesses. Ultimately partnerships

between these three will be the most effective. However, a major impediment at the present time is the lack of a cohesive environmental education curriculum within our schools.

3. The environmental impacts of plant protection systems must be more effectively monitored by users, suppliers and public agencies. Self regulation systems must be designed to deal with any renegades within industry. Monitoring must be long term and take particular account of potential cumulative effects.
4. Plant protection R and D must increasingly focus on inter-disciplinary research, with a systems orientation and include studies on societal concerns of plant protection products and practices associated with a range of options. The future of plant protection has to be a mixture of more specific pesticides, biological control of all types, breeding for resistance and GMOs (genetically modified organisms). Application of research findings (ie, use of new products or bio-control releases) will increasingly only be possible if there is a wider understanding, within society, of their benefits and risks. It is not simply a matter of assessing the biophysical risks and calculating probabilities. It is increasingly necessary for understanding of the wider concerns of society, particularly those that have inter-generational dimensions.
5. The promotion of plant protection products needs re-examining in terms of the concerns it creates in the minds of the vast numbers of non-users who view, for example, television advertisements for plant protection products. It may be that some current forms of promotion, and of application (ie. aerial spraying), simply increase societal anxiety, resulting in decreased acceptance across the whole spectrum of plant protection options, many with desirable environmental qualities.

Keywords: ecosystems, environmental education, plant protection, risk, trust.

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