AGDEX 680

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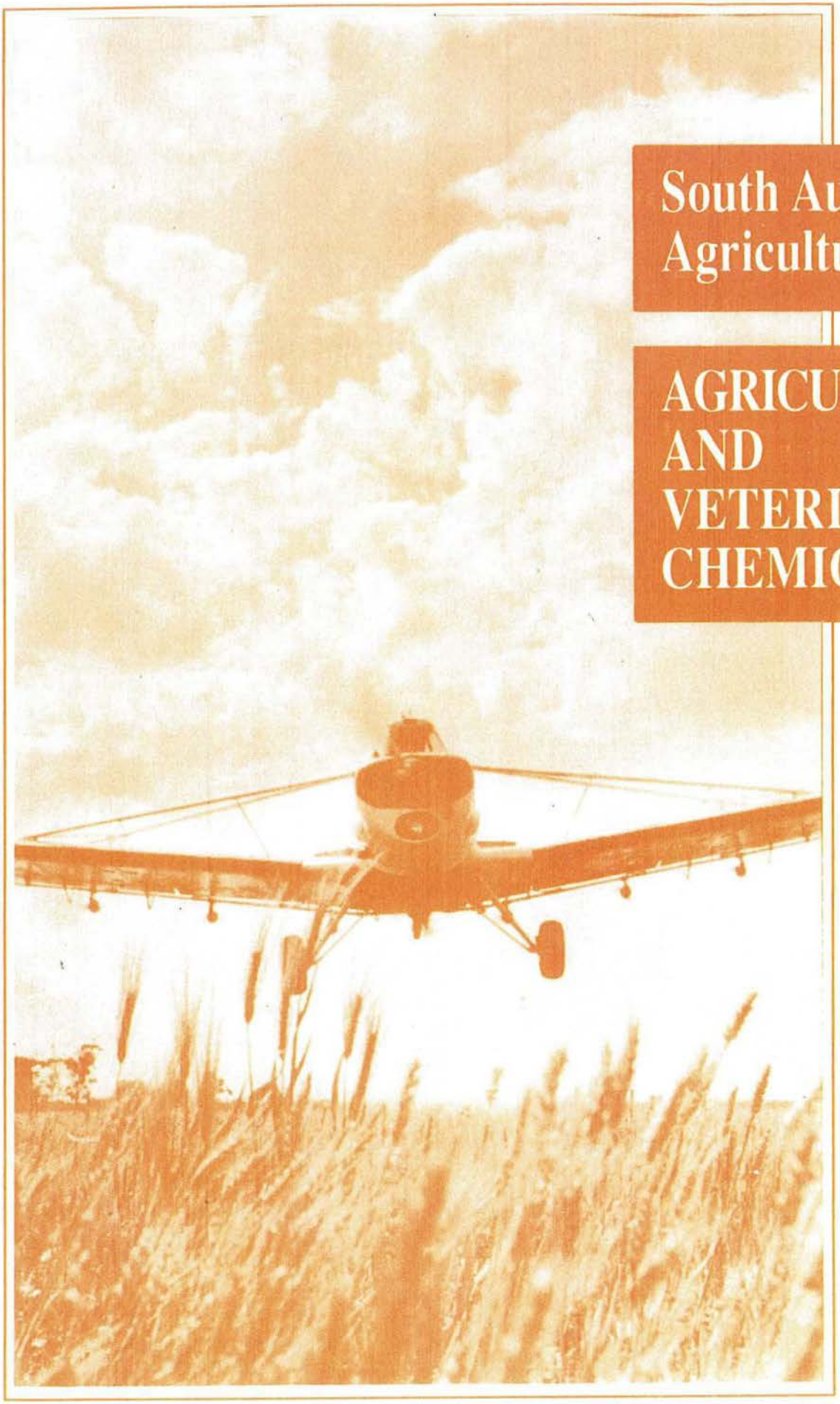
South Australian Agriculture

AGRICULTURAL AND VETERINARY CHEMICALS



January, 1992

DEPARTMENT OF AGRICULTURE
SOUTH AUSTRALIA

FOREWORD

This strategic plan is one of a series which has been developed for the principal South Australian agricultural industries and the services provided by the Department of Agriculture.

Agriculture contributes a greater proportion of returns to the State's economy than that of virtually any other state in Australia. It is therefore important to review the potential for the further development of agriculture in South Australia. These plans have been prepared by the staff of the Department of Agriculture in association with representatives of the respective agricultural industries and farmer organisations. The aim has been to identify the production potential and the market potential for the respective commodities and to thereby evaluate the opportunity which the state has to further develop its agricultural industries. At the same time, consideration has been given to identifying the most important issues to be addressed in the coming years to enable the state to achieve its maximum economic potential from agriculture. These plans will be valuable for determining the future provision of services to the rural community.

I should like to acknowledge the hard work and creative thought which both departmental staff and participants from industry and the farming community have put into the preparation of these plans.

John C. Radcliffe

(John C Radcliffe)
DIRECTOR-GENERAL OF AGRICULTURE

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INTRODUCTION

Agricultural and veterinary chemicals have assumed a high profile in recent years. In 1987 Australia was on the verge of losing major meat markets due to residues of persistent organochlorines in meat exported to the USA. A growing community awareness of environmental issues has at time been directed at agricultural and veterinary chemicals as potential polluters. Similarly, the possibility of chemical residues in food has captured community concerns. Yet farmers world wide rely on agricultural and veterinary chemicals to be able to produce the quantity and quality of agricultural produce demanded by a growing world population. Australia is an efficient agricultural producer and relies on exports of agricultural produce to earn valuable foreign exchange.

Much of the material in this report reflects this conflict between the potential dangers of chemical use on the one hand and, on the other hand, the need to keep using them in agricultural production. Decisions about chemical usage are always compromises. Whether at an Australia-wide level or at the level of a single farm, the decision is always based on the relative balance between the costs of using agricultural and veterinary chemicals and the costs of not using them. The solution to the conflict is for agriculture's dependence on chemicals to be reduced and for more acceptable alternatives to current chemicals to be found. These themes are emphasised throughout this report.

It is also apparent throughout the report that veterinary chemicals are not as contentious as agricultural chemicals. This can partly be attributed to the fact that a number of veterinary chemicals are prescribed or administered by qualified veterinarians who have expert knowledge about using such substances. The community is also less aware of stock medication than it is of crop spraying given that spraying is often a highly visible activity. To the extent that veterinary chemicals are supervised by veterinarians, the lower profile of veterinary chemicals is warranted. However, a large number of substances are available for the mass medication of stock, including anthelminthics, insecticides and feeding supplements. These substances have the same potential to lead to problems of chemical misuse or overuse, and should be treated with the same caution as pesticides.

INDUSTRY STATEMENT

BACKGROUND

A glossary of the technical terms used throughout this report has been assembled on page 113. The following definitions are given at this point since they are terms which will be used constantly.

Agricultural chemicals are pesticides, adjuvants, conditioning agents and other chemical tools used to improve agricultural production, protect crops or control pests, diseases and physiological conditions of crop plants. Agricultural chemicals can also referred to as plant protection products.

Veterinary chemicals is a general term applied to all chemicals used for treating and protecting animals from pests and diseases and in supplementing their rations. Veterinary chemicals are also referred to as stock medicines, veterinary drugs or animal health products.

Fertilisers are sometimes regarded as a special type of agricultural chemical and are materials added to the soil to augment plant food supplies.

Farm chemical is a general term used to describe all chemicals used on farms to assist in the growth of plants and animals and to protect them from diseases. That is, farm chemicals include both agricultural chemicals, veterinary chemicals and fertilisers. It should be noted that the same chemicals are also used in non-farm situations, such as parks and home gardens.

Agricultural and veterinary chemicals can be used to eradicate or control a wide range of different pests and diseases and to enhance the appearance or performance of almost any type of plant or animal. The variety of people and organisations who use agricultural and veterinary chemicals is equally great.

Chemical types

acaricides	desiccants	nematicides
algaecides	fertilisers	predacides
anthelminthics	flukicides	piscicides
antibiotics	fungicides	rodenticides
avicides	growth regulators	preservatives
bactericides	herbicides	slimicides
chemotherapeutics	insecticides	trace elements
coccidiostats	miticides	vaccines
defoliants	molluscides	vitamins

Users and use situations

Primary producers

Aquaculture
Farmers
Graziers
Horticulturists
Commonwealth Government
Railways
Defence forces

Aviation authority
Quarantine requirements
Statutory authorities
Animal and Plant Control Commission
Grain handling facilities
Private sector
Licensed Pest Control Operators
Households
Veterinarians

State government authorities
National parks
Electricity
Woods and Forests
Public health
Local government
District Councils
Animal and Plant Control Boards
Parks
Sporting grounds
Educational institutions
Ground maintenance
Universities

CHEMICAL INDUSTRY STRUCTURE

Industry Organisations

The agricultural and veterinary chemical industry is represented by three organisations:

The Agricultural and Veterinary Chemicals Association of Australia (AVCA) represents companies involved in the manufacture, formulation, development and marketing, reselling or commercial application of farm chemicals. Companies represented account for over 90 per cent of the factory gate value of animal health and crop protection products used in Australia each year.

The Veterinary Manufacturers and Distributors Association (VMDA) represent a wide spectrum of veterinary product manufacturers and distributors in Australia. The range of veterinary products produced by member organisations includes pharmaceuticals, vaccines, premix manufacture and veterinary wholesaling.

The Aerial Agricultural Association of Australia Ltd (AAAA) was formed in 1958. Its aims are the training of industry personnel, the development of safer and more efficient methods of aerial application of agricultural chemicals and the education of farmers on agricultural aircraft use.

International situation

Plant Protection - International:

The plant protection sector of the chemical industry is a well established industry and as indicated in Figure 1 the industry actually declined in size in real terms in 1987 by one per cent. The maturity of this sector combined with the substantial cost of staying in the industry due to the increasing cost of compliance with regulatory programs has meant a significant restructuring and rationalisation of the industry over recent years.

Most of the companies involved at the global level are divisions or subsidiaries of major chemical or petrochemical enterprises for which agricultural chemicals are a relatively small sector of the total business. The significance of this is that large enterprises may simply vacate areas which do not return a sufficient level of profitability or growth in favour of other enterprises. According to research by the Natwest Investment Bank Group pre-tax margins on agrochemicals are estimated to have declined from 11.5% of turnover in 1981 to 7.9% in 1987 whereas margins on pharmaceuticals increased from 18.5% to 20.7%.

The global market for chemicals was estimated in 1989 at A$28,000 million (A$=0.76US$) (AVCA). In Table 1 the top 20 companies in terms of global turnover are listed along with their annual investment in research and development and the level of these is expressed as a percentage of turnover of each company's "own sales", i.e. not including distributed products purchased from other companies.

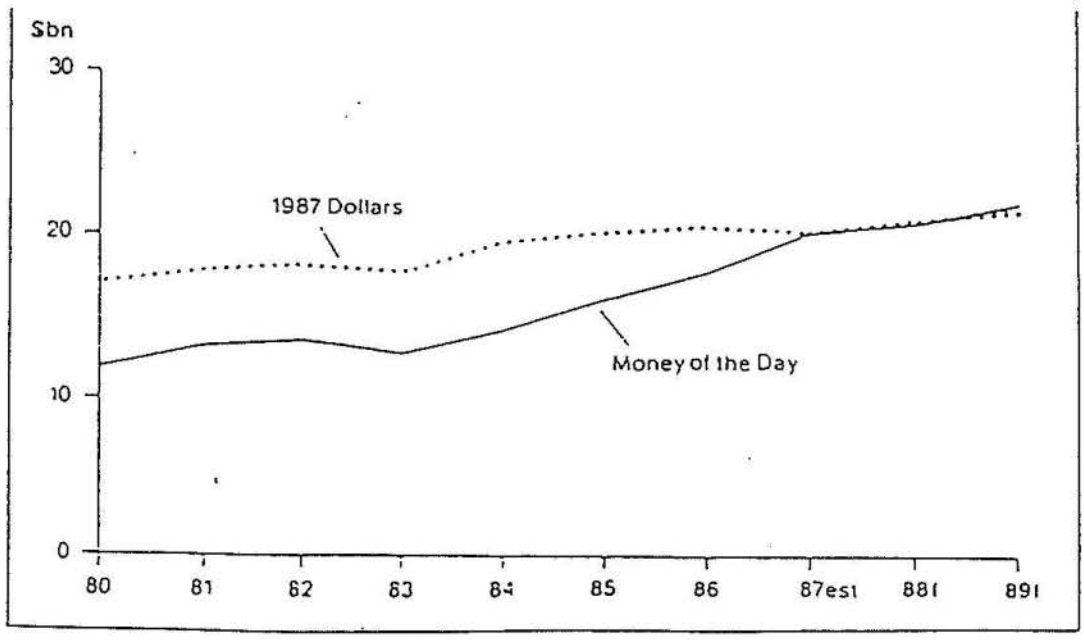


Figure 1 Global crop protection market (Source: McGuffog, 1989, p 4, quoted from Animal Pharm. Review, 1988).

Company	Sales ($m)	R & D ($m)	R & D as % of sales
Ciba-Geigy	2 050	185	12.0
Bayer	2 020	219	12.9
ICI	1 800	135	9.0
Rhone-Poulenc	1 625	144	11.1
Du Pont	1 195	104	10.0
Monsanto	1 178	94	8.3
Shell	1 050	74	12.8
BASF	1 020	105	12.7
Hoechst	930	105	14.7
Dow	819	98	13.3
Schering	756	87	17.9
Sandoz	646	60	13.0
American Cyanamid	585	58	10.7
Kumiai	440	20	6.7
Eli Lilly	408	47	12.7
Sanko	360	21	14.6
FMC	350	48	14.1
Nihon Nohyaku	345	27	20.0
Hokko	324	13	38.2
Rohm & Haas	302	39	14.7

The total value of world-wide sales of plant protection chemicals at the end-user level in 1987 is estimated at US $20,000 million.

Table 1 Global sales and research and development expenditure estimates (1987) for agricultural chemical products (Source: McGuffog, 1989, quoted from County NatWest Woodmac, 1988).

Company	Sales ($m)
Pfizer	492
Rhone-Poulenc	395
Hoffman-La Roche	369
MSD Agvet	327
Elanco	309
Bayer	292
Coopers	264
Hoescht-Roussel	263
Smith Kline	250
American Cyanamid	215
Solvay	176
IMC/Pittman-Moore	159
Upjohn	153
Beecham	146
Sanofi	130
Ciba-Geigy	107
Takeda	105
Syntex	86
Monsanto	86
Boehringer-Ingleim	80

Table 2 Global sales of veterinary chemical products (Source: McGuffog, 1989, quoted in Animal Pharm. Review, 1988).

Animal Health - International

The global market in 1989 was estimated at A$13,600 million (A$ = US$0.76) (AVCA, quoted in Animal Pharm. Review, Issue 214, 1990). Demand for animal health products has been essentially static over recent years with a general depression in the livestock markets in the Northern Hemisphere. Research expenditure appears to be generally lower than for plant protection chemicals. Table 2 lists the leading 20 companies in animal health and nutrition with their global turnover in 1986.

Market	Agricultural Chemicals ($m)	Veterinary Chemicals ($m)	Total ($m)
Domestic	420	170	590
Export	17	3	20

Table 3 Agricultural and veterinary chemical sales 1987 (Source: McGuffog, 1989).

Australian and South Australian Situation

The total Australian industry turnover at the factory gate in 1987 was estimated at $610 million of which $590 million was in domestic sales and $20 million in export sales. The domestic market figure includes a degree of double counting as it includes sales of technical materials and finished products to industry members who, in turn, sell through their own distribution channels. The basic domestic market value at the factory gate in 1987, excluding double counting, is set out in Tables 3, 4 and 5. Sales for 1988 and 1989 are also shown.

The top 19 companies (AVCA members) account for over 90% of the sales turnover of basic manufacturers and formulators. Some companies sell both animal health and plant protection products as indicated in Table 6.

	1987 ($m)	1988 ($m)	1989 ($m)
Insecticides	98	120	111
Fungicides	35	37	49
Herbicides	284	367	403
Other	20	23	22
Total	437	547	585

Table 4 Agricultural chemical sales in Australia 1987 (Source: AVCA).

	1987 ($m)	1988 ($m)	1989 ($m)
Anthelminthics	66	95	107
Vaccines	16	18	24
Ectoparasiticide	47	72	85
Other	60	64	67
Total	189	249	283

Table 5 Veterinary chemical sales in Australia 1987 (Source: AVCA).

As can be seen from Table 6 the Australian industry is comprised principally of divisions or subsidiaries of the major internationally operating companies in both the animal health and plant protection sectors. The exceptions in the animal health sector are Robert Young and Websters (who manufacture vaccines) and, although not listed in the above, Commonwealth Serum Laboratory who are also in the animal vaccine area. Biotechnology Australia, The CRA subsidiary, is a major investor in biotechnology research in the animal vaccine area. In the plant protection sector Nufarm is a publicly listed company with no affiliations with international companies. ICI is a publicly listed company in which ICI PLC (U.K.) has a 62% shareholding and Incitec is a publicly listed company in which ICI Australia has a 66.65% shareholding.

Company	Agricultural chemicals	Veterinary chemicals
Bayer	✓	✓
Ciba-Geigy	✓	✓
Coopers		✓
Cyanamid	✓	✓
Du Pont	✓	
Elanco	✓	✓
Hoechst	✓	✓
ICI	✓	
Incitec	✓	
Merck Sharp & Dohme		✓
Monsanto	✓	
Nufarm	✓	✓
Pfitzer		
Rhone Poulenc	✓	
Robert Young		✓
Schering	✓	
SmithKline & French		✓
Syntex		✓
Websters		✓

Table 6 Chemical companies producing agricultural and veterinary chemicals (Source: McGuffog, 1989).

The basic industry in Australia is a formulating industry based on imported technical grade active ingredients. Only three companies in the plant protection area manufacture technical grade actives, all being herbicide products, and one company manufactures a technical grade anthelminthic.

The linkage of the international industry with the Australian industry and distribution channels to farm users is illustrated in Figure 3. It is estimated that fully formulated products to a value of $30 million are imported for repackaging and sale under Australian labels.

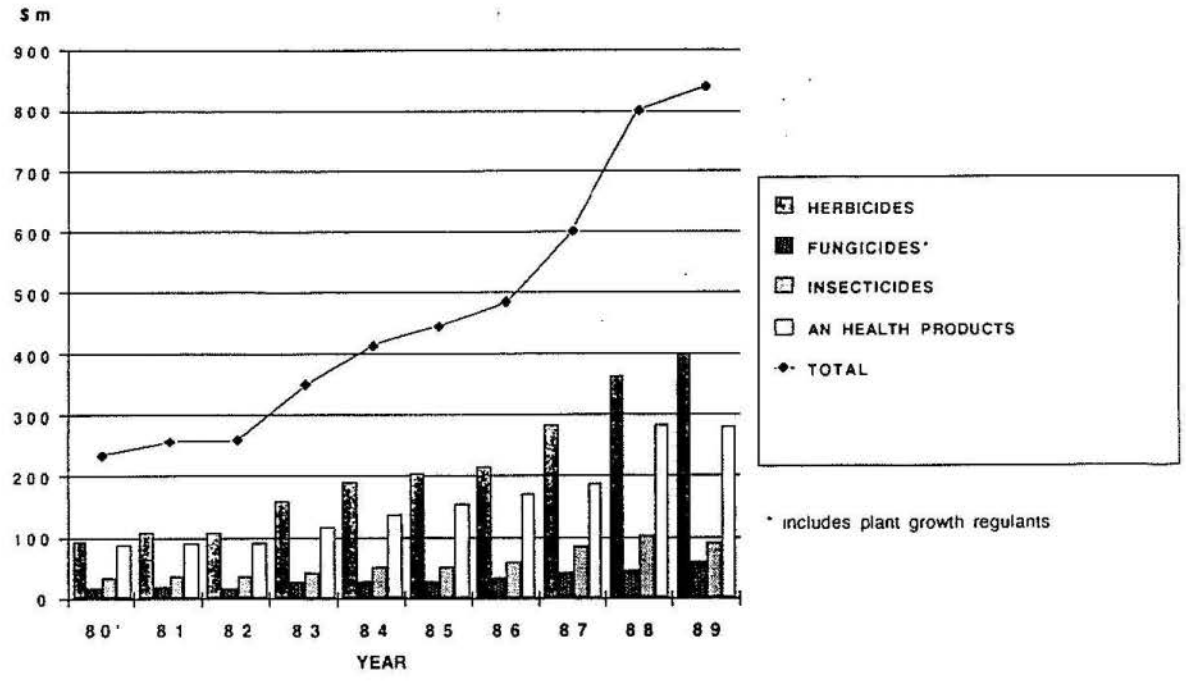


Figure 2 Australian sales of agricultural chemicals by product type (Source: ABARE).

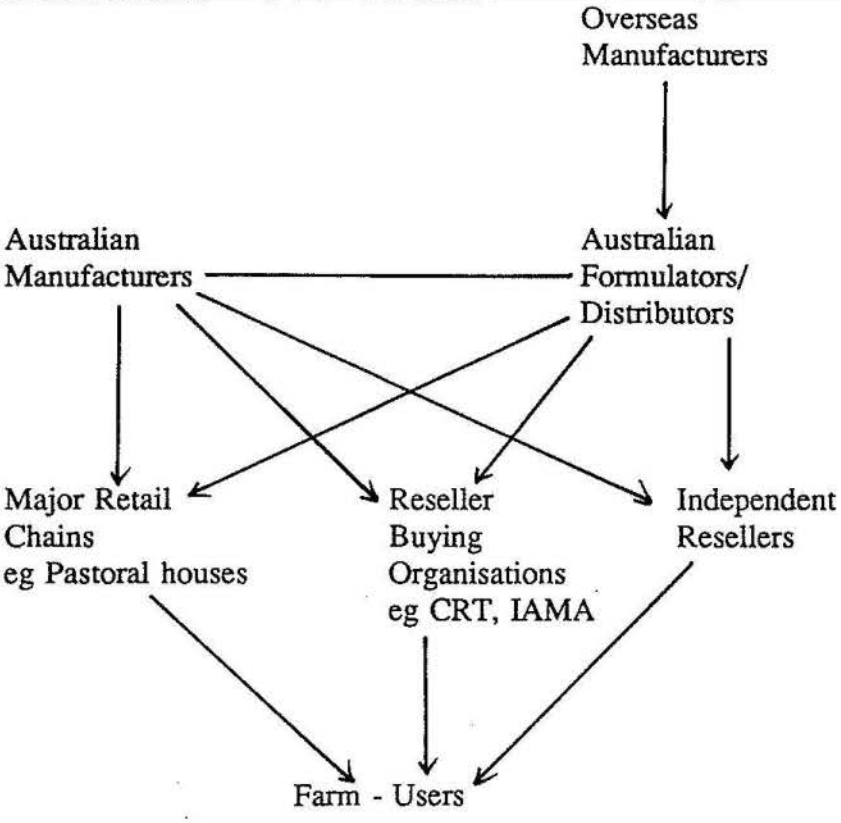


Figure 3 Links between the Australian chemical industry and the international industry (Source: McGuffog, 1989).

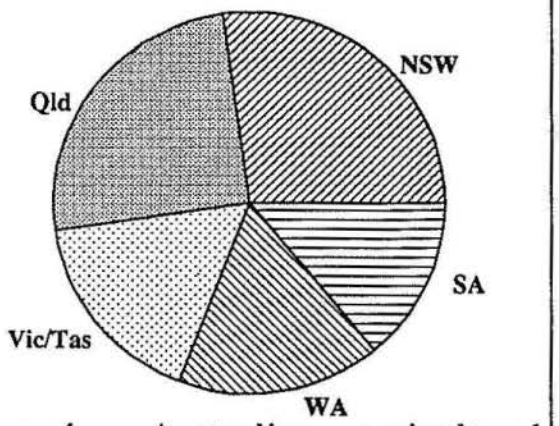


Figure 4 Australian agricultural chemical sales by State (Source: McGuffog, 1989).

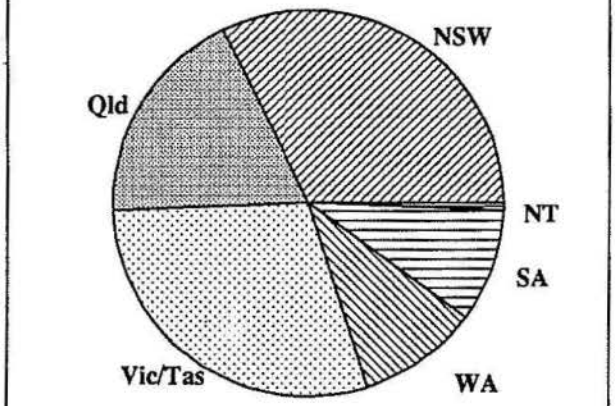


Figure 5 Australian veterinary chemical sales by State (Source: McGuffog, 1989).

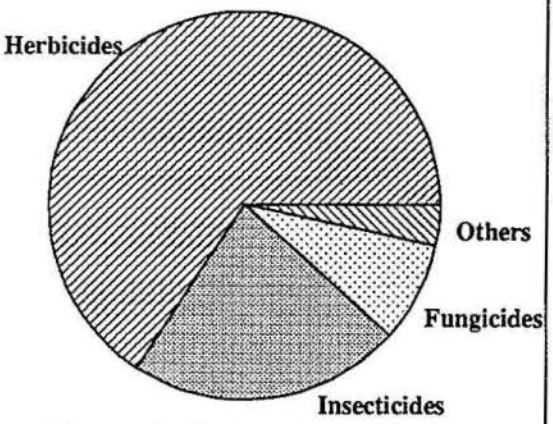


Figure 6 Agricultural chemical market by product category (Source: McGuffog, 1989).

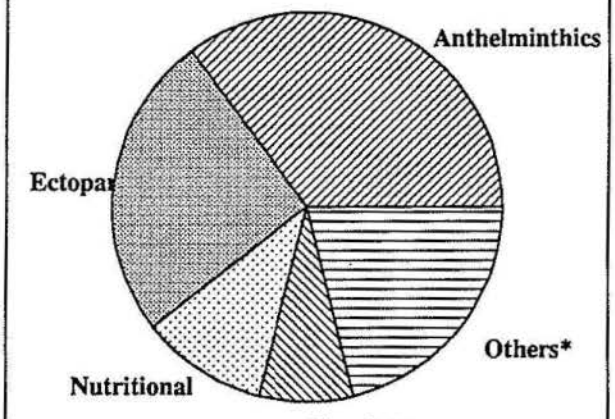


Figure 7 Veterinary chemical market by product category (Source: AVCA).

*** includes veterinary pharmaceuticals**

Market Segmentation:

The estimated domestic sales turnover by State for plant protection and animal health products is set out in Figures 4 and 5. Sales by major product categories for plant protection products and animal health products are set out in Figures 6 and 7 respectively. The total sales figures are those estimated from the basic market in 1987 set out in Tables 3, 4 and 5 with segmentation estimates based on internal AVCA sales audits.

	Agricultural chemicals ($'000)	Veterinary chemicals ($'000)	Total ($'000)
Domestic product markets	12,112	11,324	23,436
Overseas product markets	2,730	1,416	4,146
Total expenditure	14,842	12,740	27,582
Total capital investment	5,465	15,206	20,671

Table 7 Research and development expenditure and capital investment (Source: AVCA).

Research and Development in Australia

	Agricultural chemicals	Veterinary chemicals	Total
		(Number of people)	
Higher degrees	6	32	38
Graduates	155	77	232
Others	51	95	146
Total	212	204	416

Table 8 Human resources in research and development (Source: AVCA).

For the trading year of 1987 AVCA members spent $27.6 million on research and development programs. The total capital invested by the industry in R&D facilities in 1987 was $20.7 million with a total of 416 people employed in research and development. A dissection of R&D statistics obtained by AVCA's 1988 survey of expenditure and resources in 1987 is set out in Tables 7 and 8.

In addition to expenditure by AVCA members, it is estimated that a further $3 million is spent by other industrial organisations, CSIRO and in grants from the Australian Wool Corporation and the Australian Meat and Livestock Corporation.

An estimate of the total expenditure from all quarters of $30 million represents approximately 5% of the total industry turnover in 1987. This expenditure is significantly lower in percentage terms than the expenditure by overseas companies in the plant protection area, but comparable in the animal health area. Research in Australia generally concentrates on field research and adaptation of basic new chemicals to suit Australian conditions, and formulation research and development. The major cost item for new product development lies in toxicological and environmental research spending and almost all of this is undertaken overseas by the basic companies.

TECHNICAL CHANGES IN THE CHEMICAL INDUSTRY

Australia accounts for probably less than 1 percent of the pesticide end user market. An approximate world breakdown is:

USA/Canada	31%
Western Europe	22%
Latin America	12%
Japan	12%

Internationally and locally the breakdown of plant protection use areas are approximately in the order of:

Herbicides	67%
Insecticides	22%
Fungicides	7%
Others	4%

The above ratios can, however, vary from county to county. The implication of this, when allied with the cost of developing a molecule, is that products are not going to be developed specifically for the Australian market. It also means that in the case of a rapid crop expansion the demand for registered crop protection products can temporarily outstrip the registration process.

New Pesticide Development

The rate of release of new products has declined (Figure 8). This has been partly the result of increasing requirements for data on new products and more stringent screening processes. Developing a new pesticide is time-consuming and expensive. It can take up to 15 years and cost $50 million (Figure 9) to put a new product on the market.

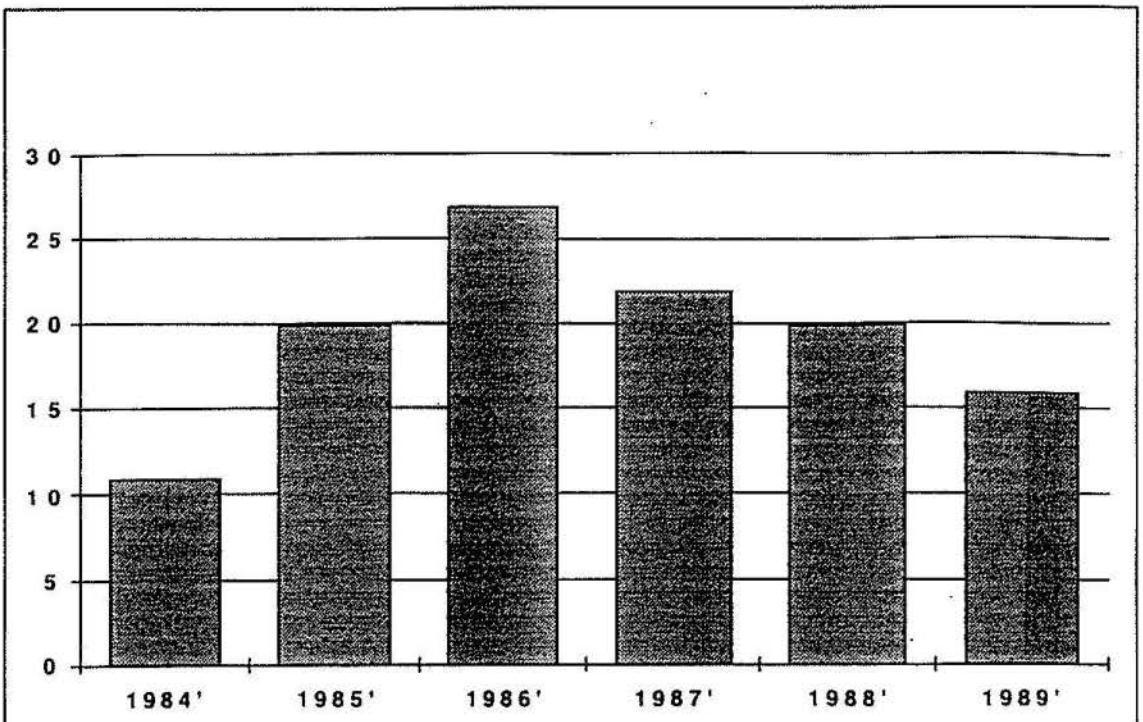


Figure 8 New product introduction (Source: Foulkes, 1990).

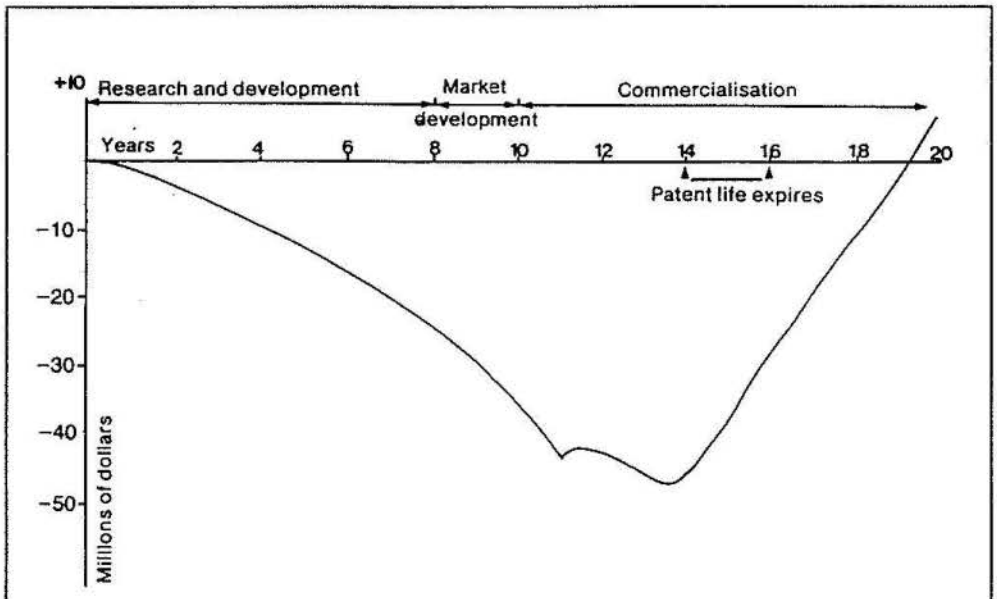


Figure 9 The cumulative cash flow related to the development and exploitation of an agricultural chemical by a corporation (Source: DARA Agnote).

Prior to World War II most pesticides were inorganic chemicals, simple aliphatics or substances of biological origin. These compounds in comparison with later developed synthetic organic chemicals were often expensive, ineffective, toxic to a wide range of organisms as well as the target species and often either non-degradable in the case of the organics (leading to residue problems) or too rapidly degradable.The synthetic organic pesticides such as DDT developed in the 1930's, were a major breakthrough. DDT's low cost and low toxicity to people enabled its use to be undertaken on a scale not possible with earlier pesticides. The problem of widespread DDT use; its toxicity to an unacceptably broad range of non-target organisms including vertebrates, and environmental persistence, were really second order effects when compared with earlier pesticides (ASTEC 1989). A number of second and third generation synthetic organic pesticides have now been developed.

Improvement in toxicity profile

In the past more toxic materials were used because no alternatives were available. There has been an improvement in the availability of a range of products of lower toxicity thus reducing environmental impact and inherent toxicity - an example can be seen in Figure 10.

Degradability

Pesticide research has led to an improvement in selectivity and environmental behaviour of chemical products. The reduction of the extent to which pesticides accumulate in the environment is being achieved through a combination of decreased rates of application and increased degradability. Figure 11 shows this trend in pesticides. The compounds are arranged in line of introduction to the market place. The histogram shows the potential of an insecticide to be distributed and cumulated in the environment is reduced by the decreased rate of application (indicated by bar size), by the degradability of the pesticide and by its ability to be absorbed on soil particles (sorption). Thus the potential of the pesticide to be distributed and cumulated in the environment diminishes with decreasing size of the composite bars and with the shift of the bars to the bottom half of the graph.

The trend is for a lower rate of pesticide to be applied per unit of area treated. This has obvious advantages as well as improving logistics of reducing quantities of carrier (water) required, reducing "down time" in spray operations, and improving timeliness of operations.

Formulation and application technology

There have been a number of developments in spray application technology. Nevertheless the use of hydraulic nozzles remains the major means of applying liquid-based pesticide products. There has been a significant improvement in the understanding, research and dissemination of information on the spray application of chemicals. Specialised equipment is utilised in specific areas, for example, controlled droplet applicators (CDA) on aircraft, or weed wipers. Specialised research and teaching institutions are also available, for example the Pesticide Application Centre, The University of Queensland, Lawes Campus.

PESTICIDE TOXICITY

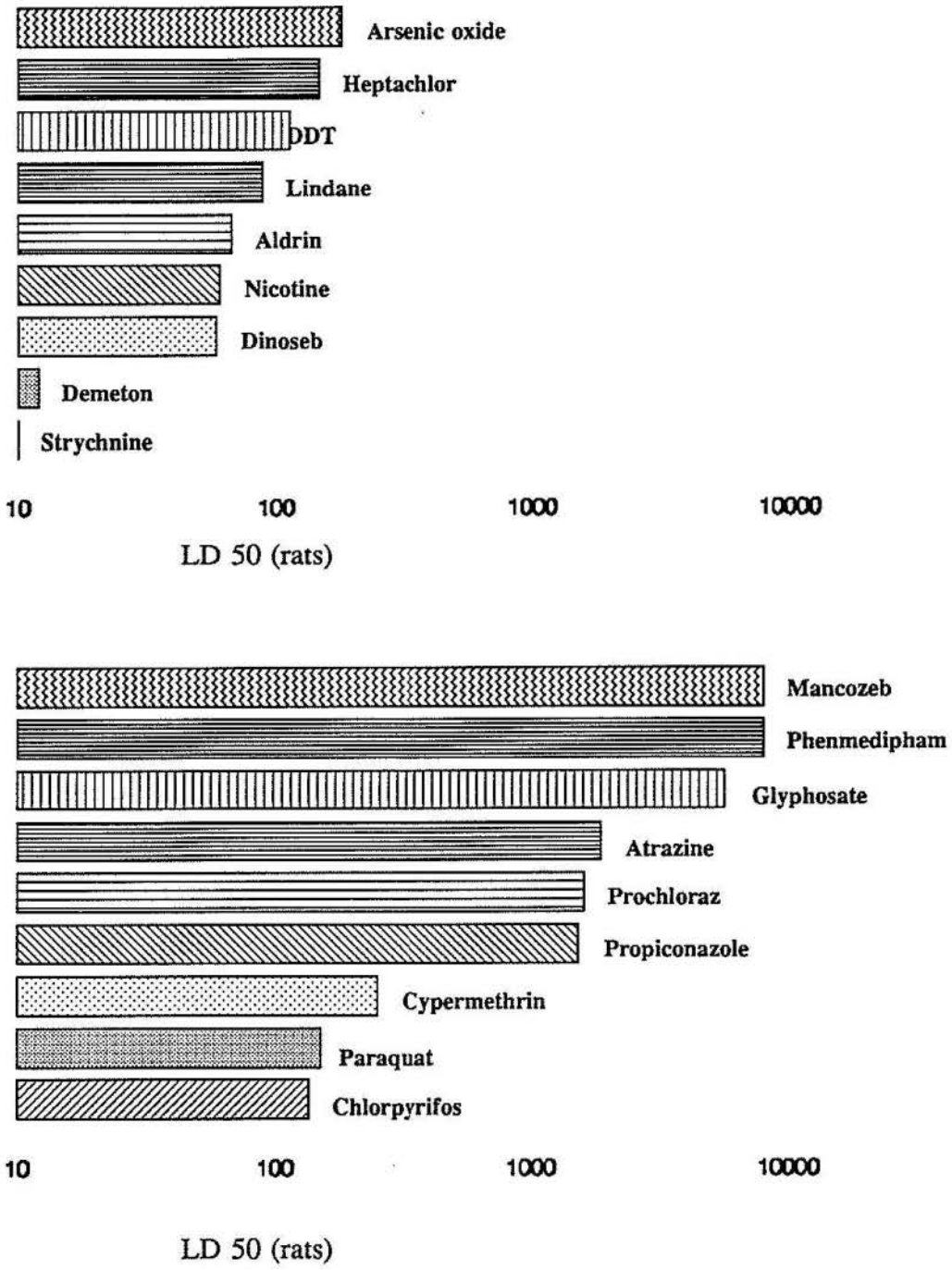


Figure 10 Comparison of toxicity of early pesticides (upper graph) and more recent pesticides (lower graph). The smaller the LD 50, the more toxic the substance.

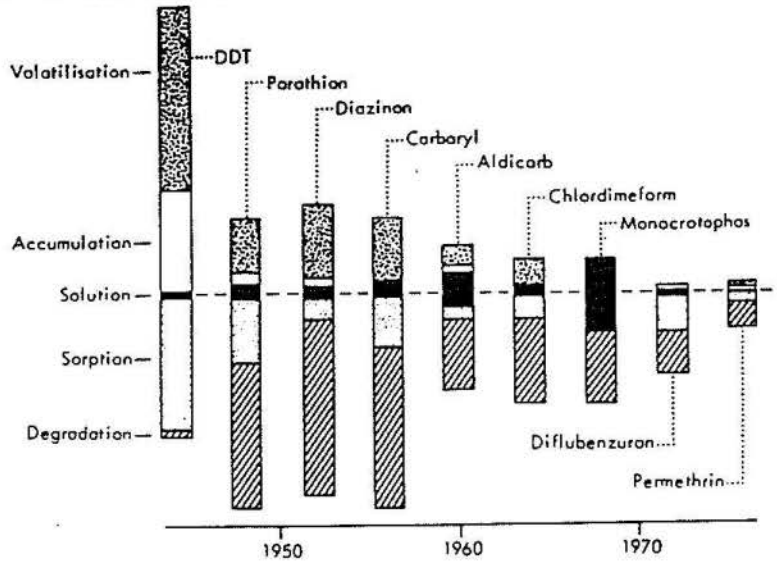


Figure 11 Potential for a pesticide to be distributed or cumulated in the environment (Source: Schwinn and Geissbuhler, 1983).

Graph based on:

DDT	1942
Parathion	1946
Dieldrin	1948
Diazinon	1951
Chlordimeform	1963
Monocrotophos	1965
Diflubenzuron	1972
Permethrin	1973
Decamethrin	1975

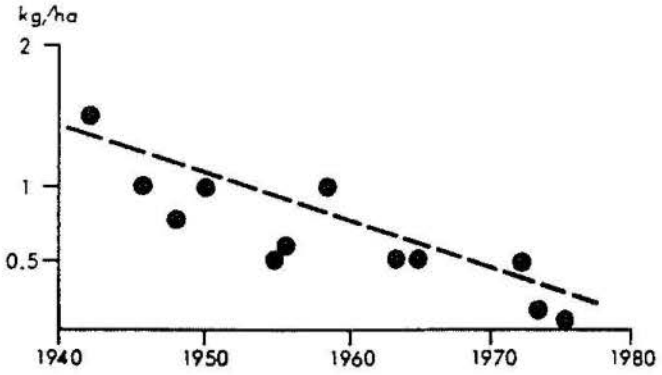


Figure 12 Evolution of rate of application of insecticides (Source: Schwinn and Geissbuhler, 1983).

Progress has been made in the area of soil applied pesticides in granular form. The Australian development of controlled release granular insecticides and nematicides has resulted in world wide interest as it enables the use of environmentally non-persistent materials in a form that will provide extended control and protection. These formulations have also resulted in a significant reduction in dermal and oral toxicity compared to conventional formulations (Incitec-pers. comm.)

Another significant Australian development in animal health has been the initial research by CSIRO on controlled release devices for therapeutic agents in ruminant animals. Formulation techniques have also played a role in the development of "pour on"

drenching.

Another major new development in pesticides are the avermectins and milbemycins, which are products obtained by the fermentation of the soil fungus species Streptomyces. There are also good prospects for the development of further pesticides from microbiological sources that will have high biological activity in target species and low mammalian toxicity (ASTEC 1990).

Biotechnology

Developments in biotechnology could provide some alternatives to synthetic chemical usage. In many cases it simply enables old techniques to be undertaken faster. Breeding of pest resistance in animals and plants has long been practised. However, biotechnology can assist the development of superior stock by identifying the genes contributing to resistance, increasing the rate of breeding through cloning and by transferring resistant genes across species boundaries. Biotechnology can also be used for modifying bacteria, viruses and fungi for use as insecticides. There is also progress in the development of vaccines to replace the use of antibiotics as well as to provide resistance to pests and parasites.

In the next ten to twenty years, it is expected that a specific area of the chemical insecticide and animal health products market will be taken by biotechnology products. There would seem to be less promise in developing biotechnology alternatives to chemical herbicides and fungicides (ASTEC 1990). In contrast Finney (1988) says it is unlikely the new biological products will constitute more than five percent of the total crop protection market by the year 2000. Thus it is likely that there will be an overall increase in the number of biotechnology based products used, particularly in the veterinary chemical area. It is likely that some growth promotant products produced from fermentation technology will be available in the early 1990's.

In the plant protection area, investment in biotechnology research is estimated to be around ten per cent of the total invested in research. For the leading twenty companies the total is around $1,700 million (D.R. McGuffog, 1989). Of this amount, 75% was estimated to be directed at genetic engineering in plants, and twenty five per cent in development of biopesticides.

At this stage it appears that rather than replacing conventional chemicals, the products of biotechnology will be complementary to chemical pest control. New technologies currently being worked on will have an effect on the management of pests, diseases and weeds. Their effects are listed below (R. Brown 1990).

* New higher yielding cultivars resistant to various pests and diseases will be developed using either conventional plant breeding techniques, or genetic engineering.
* More specific chemicals will be developed for use at even lower rates of application.
* Better formulations of chemicals will be developed which will be safer to use, not require solvents, and permit more versatile and timely application.
* Biological control of pests and diseases will become a viable alternative to

conventional chemical methods.

* Herbicide tolerant cultivars will be produced.
* Levels of pesticide resistance are likely to increase in some species.
* Successful pest and disease control is dependent on many factors, but our current level of knowledge is such that we have solutions to most of our problems.

While biotechnology may promise lower risks of residue contamination it raises other concerns such as Recombinant DNA safety considerations.

CONTRIBUTION OF FARM CHEMICALS TO AGRICULTURE

The export market for agricultural produce, which demands consistent high quality, earned South Australia $1.3 billion in 1987/88. Expenditure in South Australia on plant protection and animal health products is estimated at around $107 million at the factory gate (i.e. wholesale). Australian farmers are recognised as amongst the most efficient in the world - each Australian farmer on average produces enough food for 70 other people. Farm exports are about 40% of the nations export earnings.

The introduction of synthetic organic chemicals, especially after World War II, has been an integral part of the "Green Revolution". Growth in the productivity of agriculture has also been aided by improvements in genetic material, agricultural equipment and management practices, including better use of fertilisers. There are several thousand chemical formulations in use as agricultural chemicals and veterinary drugs in Australia, based on 400 active ingredients. This can be compared with the USA where over 40,000 chemical formulations are marketed for use in agriculture, based on about 600 active ingredients (ASTEC 1989).

Farm chemicals used in crop and livestock production are key inputs to improved agricultural productivity. The collective technology of the farm chemical industry has the potential to dramatically boost productivity, increase production efficiency and improve the quality of agricultural commodities.

Based on published data generated both overseas and in Australia, a productivity gain ratio of 4:1 has been assigned to the use of farm chemicals in Australia (Anon., 1986; Fitzpatrick, 1984; Pimental et al. 1980). The Food and Agricultural Organisation of the United Nations (FAO) has estimated that without the use of farm chemicals some 30% of the world's agricultural production would be lost in addition to the 20-40% which is already lost annually because of the effects of weeds, pests and diseases.

In 1987/88 the value of Australian agricultural production was $19 billion (ABARE) yielding a net margin over costs of $3.85 billion. Using the productivity multiplier of 4:1 and taking the retail factory gate value of the farm chemical industry in 1988 to be of the order $750 million (ABARE, 1988), it is estimated (AVCA) that the use of farm chemicals directly contributed at least $3 billion a year to this agricultural production. Alternatively, if the 30% of value of production which would be lost without the use of farm chemicals is taken into account, this represents some $6.3 billion contribution to agricultural productivity.

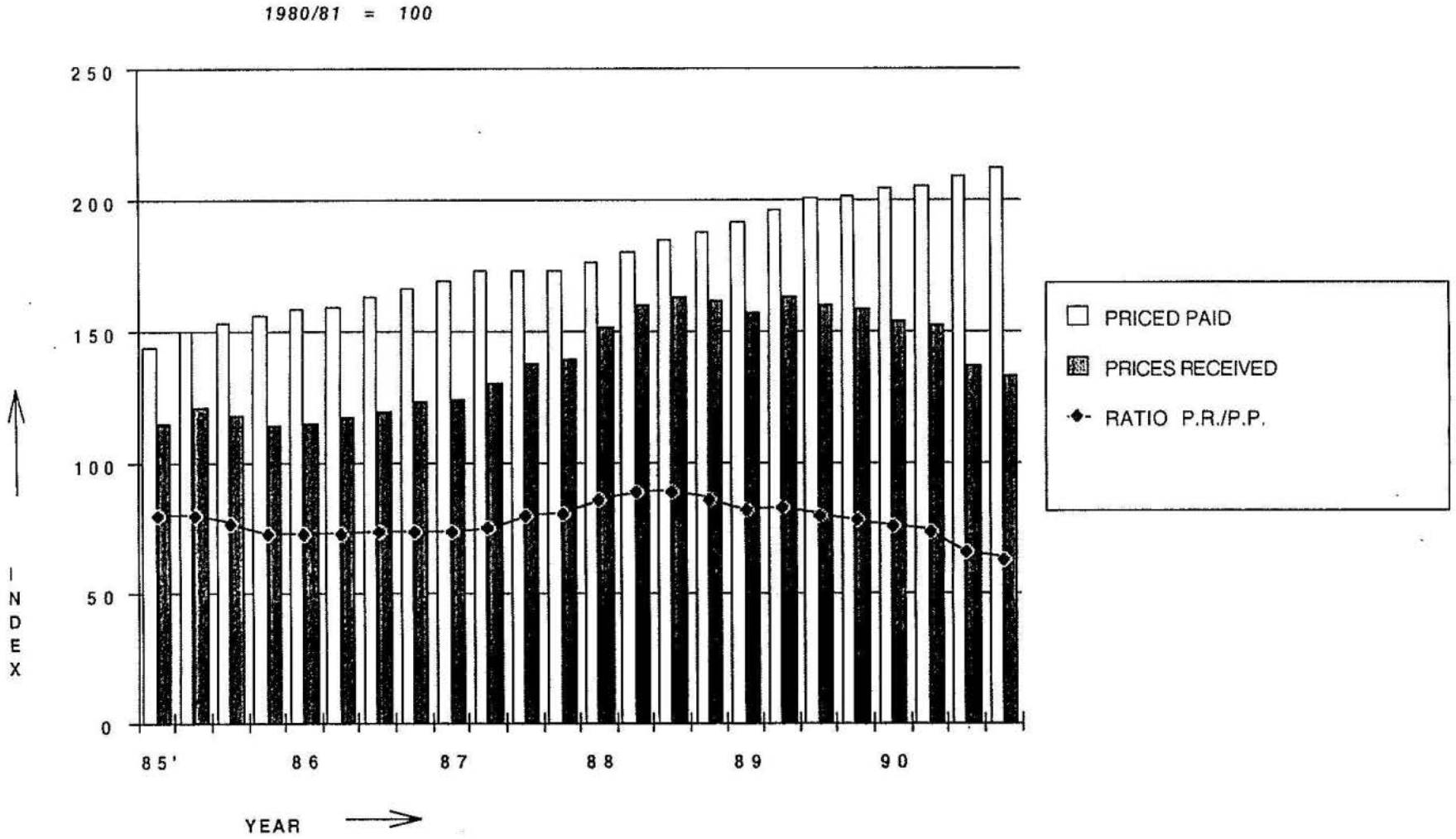


Figure 13 Quarterly indices of prices paid and prices recieved by S.A. farmers (Source: ABARE).

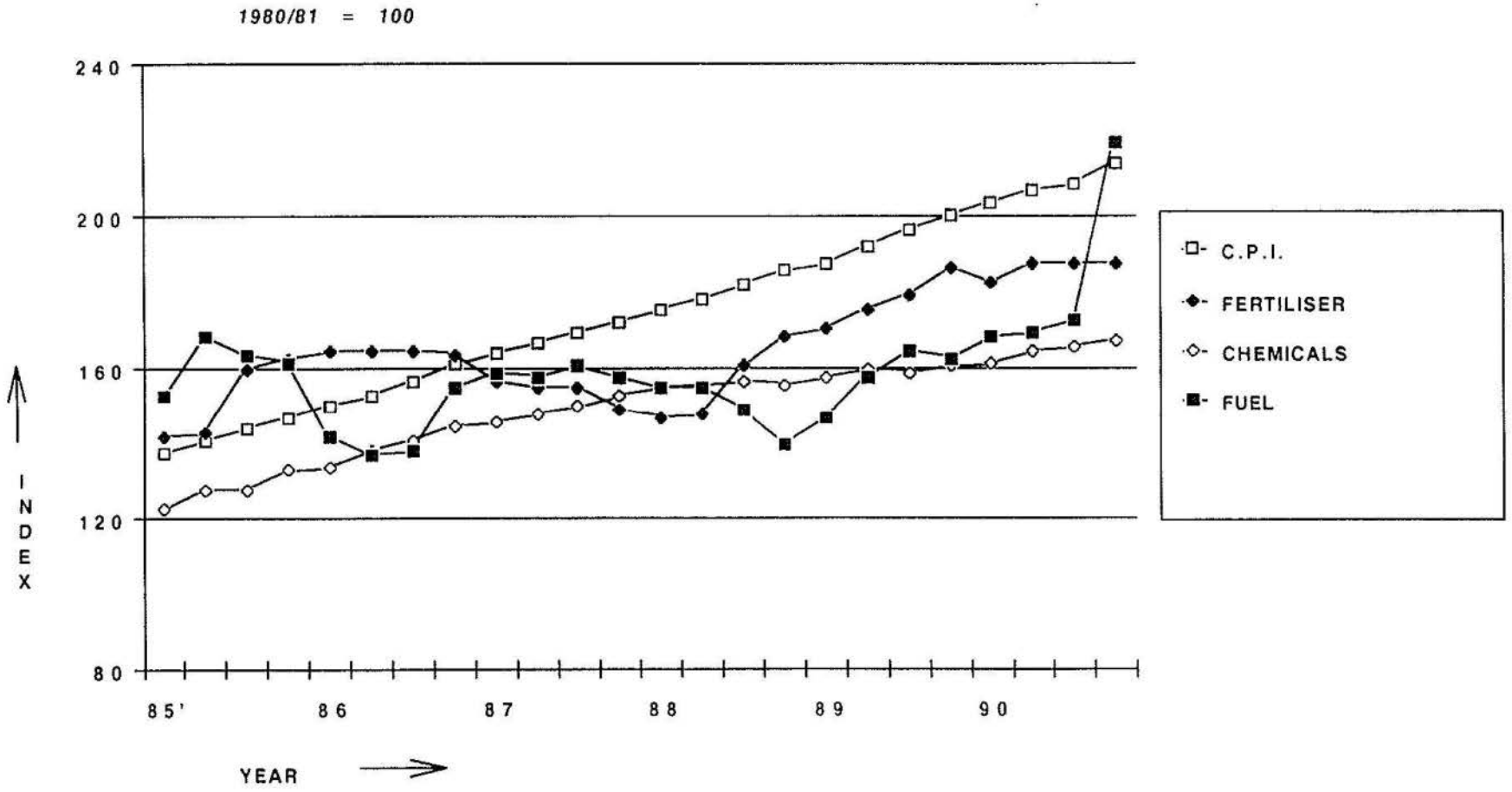


Figure 14 Quarterly indices of prices paid for selected materials by S.A. farmers (Source: ABARE).

The Need for Farm Chemicals

The decision to use farm chemicals is influenced primarily by economic costs and benefits. The cost of purchasing and using the chemical must be weighed against the expected increase in yield or productivity brought about by using the chemical and the expected value of the agricultural commodity. Economic costs and benefits influence all farm management decisions in a similar way. International economic factors are important because prices paid for major agricultural commodities are determined directly or indirectly by world markets. In the case of one of the biggest primary industries wool, 90% is exported. In the case of industries which are less dependent on exports, world market prices often determine domestic prices.

While it could be stated that all developed countries subsidise agricultural producers, in Australia, this is relatively minor. As an example, weighted producer subsidy equivalents in percentage terms are:

Japan 70

EEC 41

USA 22

Aust 6

Subsidised prices protect domestic producers from the "real world" and deny lower prices to their consumers. Farm chemicals have an important role in Australia in aiding the production of high quality products at a relatively low cost.

Prices paid for food this century show a long term downward trend, even though prices can fluctuate significantly over short periods. The effect of declining world prices on Australian agricultural commodities combined with the impact of macro-economic factors such as inflation or interest rates have aggravated the rural situation - sometimes termed a 'cost-price squeeze'. Although a great variance exists between regions, commodities and individual rural businesses, many of Australia's primary producers are obviously facing difficulties.

The terms of trade for Australian farmers (the ratio of prices received to prices paid) are likely to continue to deteriorate. Figure 13 illustrates the extent to which growth in farm costs has out paced increases in prices received. In spite of prices paid for inputs into farming systems increasing at a rate greater than prices received, the price of farm chemicals have increased at a lesser rate than the CPI increase over the same period (Figure 14).

Much of the agricultural area of Australia and South Australia has a low and unreliable rainfall. Our agriculture is dependant on export markets, and by some comparisons is low-input agriculture. Our use of pesticides is low by world standards (less than 1%) partially because of constraints of climate and yield potential. Farm chemicals are being used as an on farm adjustment to assist farmers to obtain a beneficially economic response. Unfortunately enterprises in reliable rainfall areas usually have the most farm

management options open to them and can justify purchasing farm chemicals because of the anticipated returns in yield or productivity.

Agricultural and veterinary chemicals also play an important role in protecting natural resources both on and off the farm. Pest animals such as rabbits and pest plants such as blackberry harm the native flora and fauna of Australia by degrading the environment or by more successfully competing for limited food, nutrients and water. Used judiciously, agricultural and veterinary chemicals are an effective and cost-efficient method of eradicating or controlling these pests.

The use of farm chemicals has been a cost-efficient method of increasing the productivity and flexibility of Australian agriculture, by controlling pests and diseases which would otherwise harm plants and animals or inhibit their growth.

Several examples can be given to demonstrate the role of chemical products in the farming systems of South Australia.

(i) Grain legumes - changes in cropping rotations and pesticide usage

In 1988/89 Australian grain legumes and oil seed crops had a joint estimated value of $600 million, almost one quarter of the estimated gross value of the Australian wheat crop in the same season.

The increase in the area grown to grain legumes has been caused by agronomic and economic considerations. These crops tend to be grown in areas of more reliable rainfall. These crops often require and can economically justify the use of plant protection products, mainly fungicides, insecticides and herbicides. There are also export requirements to be met, such as nil tolerance to insects. This latter requirement may affect some consignments of grain legume crops, as well as cereal crops where grain legumes may be regarded as contaminants.

(ii) Herbicides and reduced tillage

The continuing importance of preventing soil degradation has added to the significance of using herbicides to replace conventional tillage. Reduced tillage with herbicides also has a number of additional advantages, including lower machinery costs, savings of time, labour and fuel, and flexibility of sowing. For example, 1.5 litres of glyphosate saves about 6-7 litres of distillate fuel.

(iii) Herbicides, weed control and crop yields

The effect of weeds on crop production are well documented. Venn & Rovira (unpublished) demonstrated that,on a red-brown-earth soil in SA, in a year when water was not limiting, that an infestation of wild oats as low as 25 plants per square metre reduced wheat yield.

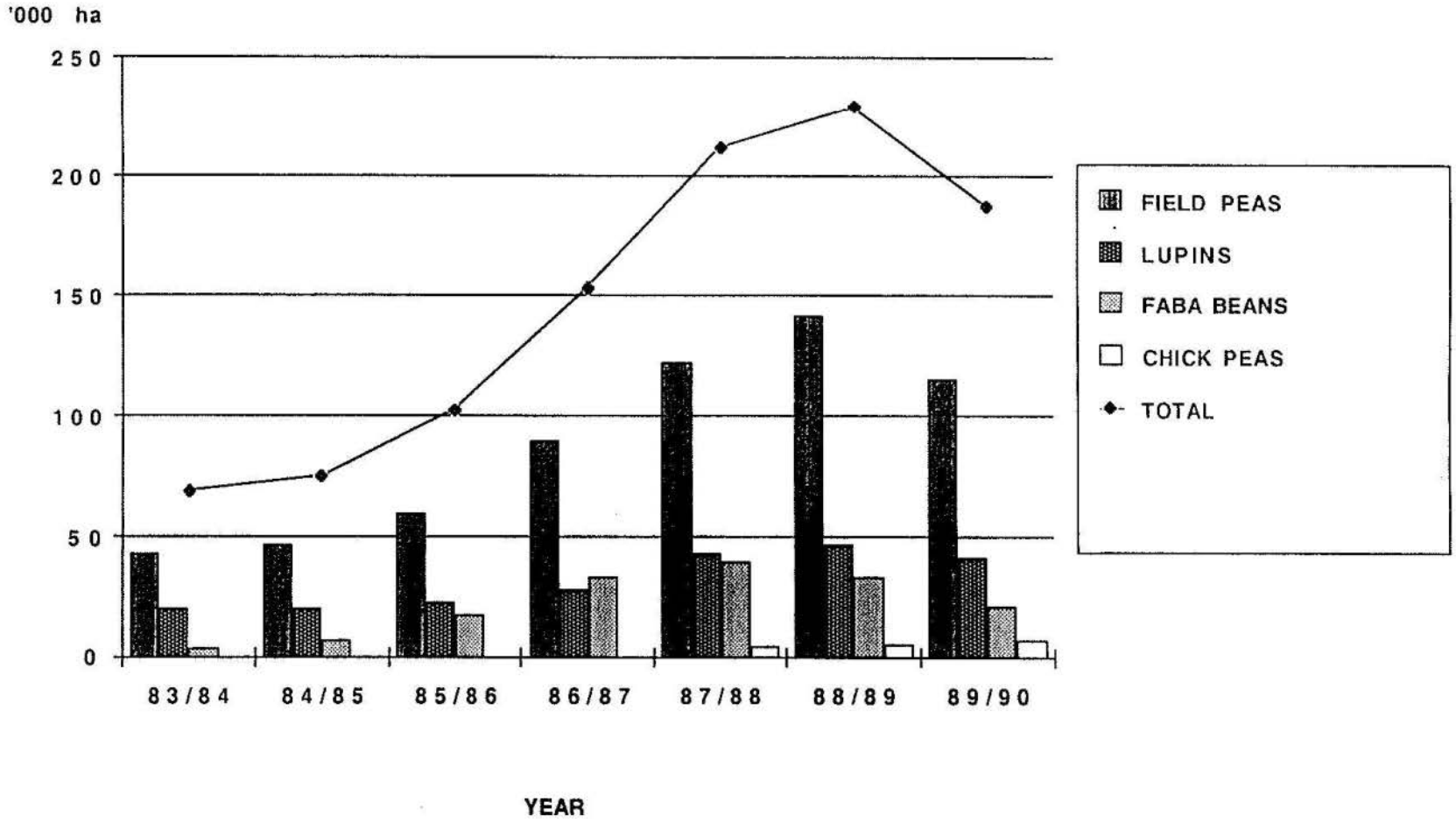


Figure 15 Area sown to grain legumes in S.A. (Source: Grain Legumes for Sustainability and Profit).

(iv) Herbicides and cereal root diseases

In Southern Australia, the major cereal root diseases are take-all, Rhizoctonia bare patch and cereal cyst nematode. These three diseases cause losses in wheat yields in excess of $300 million per annum (Rovira). Two of these diseases, take-all and cereal cyst nematode, can be controlled by removing the alternative plant hosts, but Rhizoctonia with its wide range of host plants presents a major problem.

(a) Take-all affects grasses and grass-like crops such as wheat. The removal of grasses from legume pastures and the use of grass-free break crops (oats, peas and medic) can reduce the effect of take-all on subsequent wheat yields (Rovira).

(b) Cereal Cyst Nematode, like take-all, is confined in its host range to cereals, wild oats and to a lesser extent other grasses. The removal of these hosts (especially self-sown cereals and wild oats) from pastures, grain legumes and other break crops will control this pathogen and increase crop yields (Rovira and Simon, 1982; Brown, 1987).

(c) The Rhizoctonia fungus has a wide host range. Consequently control by rotation is not as successful as with take-all and cereal cyst nematode and chemical control measures are often required. Nevertheless, the area of crop affected by Rhizoctonia are lower following grass-free medic and peas than following grassy pasture. (Rovira, 1986, 1990) Chemical fallowing several weeks before sowing has been shown in South Australia to reduce the level of Rhizoctonia damage and increase wheat yields (Roget et al., 1987).

(v) Control of flystrike in sheep

Flystrike by the sheep blowfly (*Lucilla cuprina*) is a serious problem of the sheep industry and inflicts a slow and painful death on sheep which remain untreated. It is presently estimated to cost the Australian sheep industry in the vicinity of $200 million annually and causes the death of approximately 3 million sheep each year. Though breech strike can be prevented in most circumstances by management practices such as mulesing and crutching, prevention of other types of strike such as body, poll, and pizzle strike, depends principally on the use of insecticides. In addition, insecticides and repellents form the basis of curative treatments for the 14 million sheep which become flystruck each year.

(vi) Control of internal parasites of livestock

Internal parasites include tapeworms, flukes and gastro-intestinal nematodes. Their distribution is endemic throughout the Australian grazing industries. The diseases caused by internal parasites result in reduction in liveweight gain, milk production, fertility, fibre production and fibre quality. Even mild worm burdens in young sheep have been shown to cause losses of 9-31% in fleece weight and 14-79% in body weight. Serious cases result in death. Management practises can reduce the prevalence and severity of infestation , but good control and treatment of internal parasites is dependent on the availability of effective anthelminthics.

Fertilisers

Regulation

Most Australian soils are geologically old and highly weathered, consequently low in phosphate, nitrogen and other trace elements. By world standards the use of nitrogenous fertiliser in Australia is low. Nevertheless, fertiliser in its many forms is essential for continued and or increased production per unit of agricultural area. Fertilisers are used in a wide range of agricultural situations and a large number of products are required to enable plants and animals to grow to their full potential. Details of the main plant nutrients are listed in APPENDIX D.

While the benefits in using chemical fertilisers is obvious, it must be noted that fertiliser use does have associated problems. These include:

- nutrification effects on water quality, mainly by nitrates and phosphates.
- soil acidification through continued use.
- contamination of agricultural products by heavy metals.

Regulatory requirements for fertilisers are not as comprehensive as those for pesticides and in most States are covered by part of the same Act that regulates agricultural chemicals. The main aim of fertiliser regulation is to ensure compliance to product quality standards.

Supply of fertiliser

Australia has a diverse fertiliser manufacturing industry. Domestic production gives security and reliability of supply. Overseas phosphate rock and finished fertiliser supplies cannot be assured as secure, reliable and economic sources of fertilisers for Australia. Much of the world's available fertiliser resources are located in politically unstable areas (phosphates in Africa and the Middle East and nitrogen in Eastern Bloc countries).

The world trade prices of finished fertilisers tend to be volatile. High analysis ammonium phosphates have been produced in Australia for 25 years and over the last 12 years demand for these products has increased. Anti-dumping duties and a compensating Government rebate system operate on high analysis fertilisers. Imports still provide price competition, and retain a share of the Australian market.

Manufacturing

There are 14 sites in Australia where fertilisers are manufactured - four sites produce high analysis fertiliser (Brisbane, Newcastle, Geelong and Kwinana). Phosphoric acid plants are located at these sites. Nitrogenous fertilisers are produced at Brisbane, Newcastle and Kwinana and, as basic feed stock, use natural gas from the Surat Basin, Cooper Basin and North West Shelf.

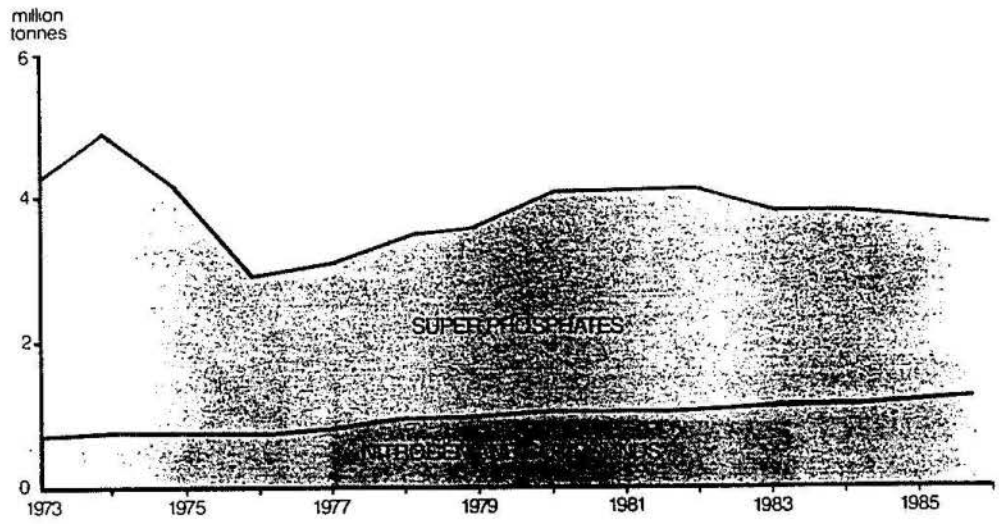


Figure 16 Fertiliser use (Source: Aust. Fertiliser Industry, 1988).

Changes in fertiliser use

There has been a shift toward the increased use of nitrogenous fertilisers, with development of diversified and more intensive farming, and new crops and techniques. Particularly in cropping industries, the demand has been for more concentrated high analysis fertilisers containing nitrogen. Whereas prior to 1974 the usual consumption ratio of N, P, and K was 2:6:1, the ratio is now 3:3:1. The relative prosperity of individual agricultural enterprises will influence future trends.

Contribution of fertilisers to the Australian Economy

The Australian fertiliser industry supplies between 3 and 4 million tonnes of phosphate and nitrogen fertilisers each year, and has a turnover of more than $1,000 million. The fertiliser industry provides direct employment in manufacturing for some 4,000 persons. Manufacture of allied products and other services employ a further 1,200. There is significant employment in distribution and transport operations.

Aside from its contribution to the economy as an employer and user of Australian resources, the fertiliser industry produces a wide range of industrial products.

* the fertiliser industry produces and uses 70% of the national production of sulphuric acid
* a range of grades of sulphuric acids are supplied to other industries including oil refineries and organic chemical producers
* gypsum is a by-product of phosphoric acid production
* copper oxide produced in SA is exported for wood preservative use

* manganese oxide is supplied for use in animal feed and manganese sulphate for uses as a trace element
* cobalt pellets are exported.

The future for fertilisers

Efforts to develop indigenous raw materials to offset diminishing overseas supplies is on going. This includes the assessment and development of phosphate rock reserves in Qld and W.A. If completed, these two projects would result in savings of $100 million per year on imports. Over ninety percent of the sulphur used to make sulphuric acid is imported, however, the development of sulphur from domestic sources is being undertaken.

Fertilisers and Organic farming

Developing a definition of chemical-free or organic farming is difficult. Organic farming has a place in today's rural economy helping to satisfy some markets. It has however, limitations due to its lower productivity per unit of input and the physical limitations of available land reserves. Organic farming is increasing in popularity in Australia, partly for lifestyle reasons and partly in response to a demand for organically grown food.

Substantially less than one per cent of Australian agriculture is grown by chemical-free methods and, with present technology and market requirements, this is not likely to change (ASTEC 1989). Organic farming moreover, is not suitable for all cropping or farm production situations. The soils of most farming regions in Australia are deficient in phosphorous and to a lesser extent potassium, thus organic farming yields would not be sustainable over much of Australia for this reason alone.

COSTS AND BENEFITS OF CHEMICAL PRODUCTS

Economic costs and benefits are one of the most important determinants of the variety of chemical products available for purchase and the pattern of chemical use in agriculture. Economic cost/benefit 'equations' determine:

- which chemical products are available for use,
- whether a chemical is used at all,
- which particular chemical products are chosen for use,
- what quantity of the chemical product is used,
- how much research is conducted into new chemical compounds,
- how much research is conducted into new or improved uses of existing chemicals,
- who conducts research.

There is no simple cost/benefit equation which can capture all the factors relevant to the availability and use of farm chemicals. The equation often differs for each type of chemical (eg herbicides or sheep dips) and each situation or area being looked at (eg. a

single farm or whole industry). The relative importance of various factors in the equation also differ according to the particular aims and constraints of each group.

The role of relative costs and benefits in the decisions of farmers and chemical companies must be taken into account if regulation of chemicals is to be successful and if other public policy objectives are to be met. In particular, the behaviour of agricultural industries and chemical companies will not change without encouragement and incentives to do so. Money saved and income gained are powerful incentives. There are a whole range of measures which could be used to achieve policy objectives, either by adjusting the price of chemicals through taxes or subsidies, or by taking advantage of the features of chemical use and availability patterns. On the other hand, government regulation is not costless. There is presently insufficient information on the markets for various chemical types (eg. insecticides or anthelminthics) to be able to estimate the costs and benefits accruing to either chemical companies or farmers. *Ad hoc* regulation or intervention can create distortionary effects which may be worse than the original problem. It is also necessary to understand that analysis of chemical markets, costs and benefits do not necessarily answer the question of who **should** pay and who **should** benefit as compared to who is currently paying and benefiting. The questions of who should pay and who should benefit must be answered on the basis of community-wide or industry-wide views and priorities.

Farmers

Farm families earn their income from the sale of the agricultural commodities they produce and all farm operations are ultimately related to the production of saleable commodities. Pests and diseases threaten to reduce the quantity or quality of saleable produce and thereby threaten family income. Similarly, pests, diseases and other factors, such as soil fertility, threaten farm income by reducing the productive potential of the farm's stock and land. Farm income is maintained (or maximised) by selecting the most cost effective solution available for preventing disease or pest damage and maintaining productivity. Farm chemicals are one of (or occasionally the only) option for preventing income losses.

Farm operators are willing to buy and use chemical products to the extent that the chemicals will add to farm income or prevent income (crop or stock) losses. This means that the anticipated income from using the chemical or, more usually, the value of preventing losses through disease or pest damage, must exceed the cost of buying and applying the chemical. The choice of a disease or pest control solution will depend not only on the availability of chemical and non-chemical alternatives, but on the cost effectiveness of those alternatives. A chemical solution may be chosen if a whole season's crop is at risk, or if even slight damage to the quality or appearance of the commodity will involve large penalties in the price for which it can be sold. A non-chemical solution may not require the purchase of any chemicals or special inputs but may not be viable for the farm if income is lost while fields are unusable or while waiting for natural predators to reduce pest populations.

The importance of a particular chemical to a particular agricultural industry depends on the degree to which a particular pest or disease threatens production, and the range of alternative solutions available. In general, chemicals are very simple, rapid, effective and cheap compared to many other disease and pest control alternatives. This is especially so

when unanticipated events threaten a whole herd or crop. For these reasons, agricultural industries will seek to protect the continued availability of those chemicals on which their production, and therefore income, depend. Agricultural industries will be willing to contribute funds to research or participate in trials on chemicals considered important to the industry, but only to the extent that they anticipate gaining income, reducing costs or preventing income losses.

It must be acknowledged that non-monetary factors can also affect chemical use. Two particularly important factors are the availability of information on chemical and non-chemical alternatives and the technical knowledge and skill of the farm operator. An abundance of information enables farmers to select the most appropriate and cost effective solution to disease and pest problems. The knowledge and skill of the operator will have a great effect on whether a sophisticated control strategy can be employed. Farmers also place importance on conservation and sustainable farming practices and often design their farm plans on this basis. Nevertheless, it is the cost equation that will generally be the final determinant of which disease and pest control strategy is chosen and which chemicals are used (if any). Even with full knowledge and deep conservation commitments, the constraint of earning sufficient income to survive and maintain the farm as a going concern means that the most cost effective solution will be chosen. Agricultural and veterinary chemicals are often the most cost effective solution.

Chemical companies

Chemical companies earn profits from selling agricultural and veterinary chemical products to farmers and other users. For a chemical product to be profitable, revenue from the sale of the chemical must exceed the research, development, regulatory and marketing costs incurred by the company in getting the chemical into retail outlets. In other words, a company will only market a chemical product if sales of the product will be sufficient to at least meet all costs. For the same reason, the company's willingness to comply with new or extended government regulations or to undertake extra research will depend on the profitability of the product or any marketing advantage that might result for the company. A company may prefer to stop selling a particular product rather than incur financial losses on it.

REGULATION OF AGRICULTURAL AND VETERINARY CHEMICALS

The regulation of agricultural and veterinary chemicals reflects the conflict that exists between the need for agricultural industries to have access to chemical products, and the necessity of restricting the use of substances which are potentially dangerous to humans and to the environment. This conflict is resolved primarily by requiring that substantial health, environmental and agricultural information is provided on each chemical so that a decision can be made on its optimum use. The optimum use for a given chemical may range form not using the substance at all through to its unlimited use. The most usual decision, however, is to limit use of a chemical by registering it for use on certain pests/diseases under particular circumstances. Other regulatory controls are aimed at ensuring that chemicals are used according to the uses for which they were registered.

New farm chemicals are cleared federally for registration at state level. **Clearance** is the process whereby a chemical is assessed for any undesirable health, safety and environmental effects and a decision made about the chemical's optimum use in agriculture. **Registration** is the point at which the information which will appear on product labels and any other final checks are made before the chemical product is registered for sale in one or more States. Local adaptive and development work to qualify for Australian product registration generally takes at least three years. The process of clearance (co-ordinated by the Commonwealth) and registration (by the States) usually takes between one and three years.

From the late 1960's to June 1989 all new farm chemicals and all new claims for existing products were assessed at a national level by the Technical Committee on Agricultural Chemicals (TCAC) or the Technical Committee on Veterinary Drugs (TCVD). Both technical committees are made up of representatives of appropriate State agriculture agencies and the National Health and Medical Research Council (NH&MRC), the National Occupational Health and Safety Commission and the Commonwealth Department of Primary Industry and Energy.

On July 1, 1989 the Commonwealth *Agricultural and Veterinary Chemicals Act, 1988* came into force. This Act established an Australian Agricultural and Veterinary Chemicals Council (AAVCC) with responsibility for co-ordinating the evaluation of chemicals proposed for registration in Australia. Responsibility for the control of sale and use of agricultural and veterinary chemicals resides with the respective state agencies that are responsible for agriculture and health.

Since July 1, 1989 the TCAC has been renamed the Agricultural Chemicals Advisory Committee (ACAC) and the TCVD is now the Veterinary Chemicals Advisory Committee (VCAC). These two groups now act as advisory committees to the Australian Agricultural and Veterinary Chemicals Council established under the federal Act.

Various specialist committees attached to the NH&MRC are responsible for assessing the health aspects of farm chemicals during the clearance process, specifically the Drugs and Poison Schedule Committee (sets safety, first aid directions and determines poison schedule) and the Pesticides and Agricultural Chemicals Committee, (which sets MRL's). Chemicals are also assessed by the National Occupational Health and Safety Commission and by environmental specialists on behalf of the Australian Environment Council and Council of Conservation Ministers. A diagrammatic representation of the clearance process is set out in Appendix B and steps in the health assessment of chemicals are set out in Appendix C.

Recently, new measures were introduced by the Commonwealth Department of Primary Industries and Energy to tighten controls over older products which had not been subject to the same level of scrutiny as more recently cleared and registered farm chemicals. The new measures mean that a significant number of existing chemicals will have to be, in effect, re-cleared. Companies which decide to maintain clearance for products affected by the new regulations were initially given until July,1986 to collect and rework toxicological, environmental, metabolism and other safety data. In some cases this meant re-trialing and re-testing products in order to meet the new, stricter clearance guidelines. Some companies have decided to voluntarily withdraw products from the market rather than meet the high costs associated with the provision of new and/or reworked data. This

is more likely to occur in the case of older chemicals which have run out of patent and which are freely available for any chemical company to produce.

The registration of agricultural and veterinary chemicals has been identified as an area where regulatory reform is possible and should result in greater efficiency and effectiveness in chemical controls. A proposal has been made to establish a single national system of chemical registration to replace the existing arrangements whereby chemicals are registered separately by each individual State/Territory in Australia.

PUBLIC PERCEPTIONS

The Agricultural and Veterinary Chemicals Association (AVCA) commissioned a major study in 1990 on consumer awareness, perceptions and fears about food safety issues relevant to fresh food. See APPENDIX E.

The study by Frank Small & Associates (Aust.) Pty Ltd addressed four major issues.

* food safety
* the environment
* consumer understanding of the use of agricultural & veterinary chemicals.
* the credibility of industry and other sources of information about farm chemicals.

The research suggested that while chemical residues in food is an issue with consumers it is not ranked as strongly as:

* water & beach pollution
* air pollution
* harm to the ozone layer
* the greenhouse effect
* chemical residues in soil & water

New issues emerging include:

* plastics which are not biodegradable
* developments in wet lands & rain forests
* the use of bleached paper products

Consumers have a positive view that the quality of Australian horticulture and livestock products are world class. However, the reason for the latent disquiet is that although most people accept that farm chemicals are required to produce large volumes of high quality fresh food they generally have little idea about the role of farm chemicals. The research found that people have no knowledge of the effort that government and the chemical industry commit to testing and monitoring farm chemicals. There is also perceived to be a problem with the way government and the associated business community react to consumer concerns about food safety when raised by the media.

The research also indicated that many people would prefer to buy attractive looking fruit and vegetables with no blemishes if the horticultural and farm chemical industry and

scientists could guarantee environmental and food safety. The survey stated there was some demand for organic food but most people stated they never see it available or if they do, it does not look as attractive as what they normally buy.

The research listed a number of ways that the chemical industry could achieve consumer confidence in public communication. These included:

* raising the awareness of integrated pest management & other solutions being promoted by the chemical industry
* honest advice about long term plans to reduce chemical usage
* the chemical industry developing strong consortiums with other relevant parties who all make the same statements.

HEALTH AND ENVIRONMENT

Improvements in agricultural productivity resulting from lower cost and increased efficiency of synthetic organic agricultural chemicals have produced a greater availability and variety of less costly agricultural products. Though the potential of chemical residues in agricultural products health effects is high, the reality is that there are few significant health effects. Exhaustive testing for carcinogenicity, mutagenicity, teratogenicity and other undesirable effects must take place to satisfy health requirements of regulatory bodies before a chemical will be registered for use. In fact, the requirements are so rigorous that it has been suggested that if some vegetables has to fulfil the same criteria they would never gain registration (Ames, 1989).

Arguments that the use of chemicals is contributing to an increased cancer rate in our society are not based in fact. Overall, Western society cancer rates are staying at the same level or decreasing. Figures from the United States National Cancer Institute comparing US rates of cancer from 1950 to the present day indicate that the age-adjusted mortality rate for all cancers combined, except lung cancer has been declining since 1950 for all individual age groups except 85 and above. There has been a steady increase in the life expectancy of Australians since the 1930's.

It is possible to set acceptable levels of chemical residues in agricultural products and the principals used by health authorities within Australia are sound (ASTEC, 1989). However, this does not mean that there is no need to modify current practices. Toxicological science is continuing to develop and it is prudent to continually re-evaluate chemicals in the light of new information.

Beneficial environmental impacts of judicious chemical use include:

* control of exotic organisms
* reduction of land degradation
* conservation of national land

Specific environmental concerns include:

* disposal of chemical containers
* disposal of agricultural chemicals
* education, training, safety & responsible use.
* impact of fertiliser use on water quality

See: Review of Agricultural Chemical Spray Drift (1991)
Senate Select Committee on Ag. & Vet. Chemicals (1990)
ASTEC Report (1989)

EDUCATION AND TRAINING

In most situations, commercial pesticide applicators, aerial, domestic and ground throughout Australia are required to be registered under some form of licensing system. See Appendix F.

The SADA has undertaken formal investigations into the suspected misuse of agricultural and veterinary chemicals since 1978.

Farmers

There is presently no necessity by law for farmers in Australia to be licensed for the application of pesticides. There are some specific exceptions to this situation. See Review of Agricultural Chemical Spray Drift.

In the view of the recent Senate Select Committee investigation into agricultural and veterinary chemicals, the licensing of users of agricultural and veterinary chemicals would be administratively burdensome and impractical. The Senate Committee considered that improved education and training is a preferred and more effective approach (Recommendation 45, Senate Select Committee on Ag. & Vet. Chemicals).

At the time when international markets, consumers and producers are responding to chemical and environmental concerns, the Senate Committee also considered that any reduction of extension services of State Departments of Agriculture would be short-sighted (Recommendation 45, Senate Select Committee on Ag. & Vet. Chemicals).

However, a voluntary course for Australia-wide farmer training has now been developed with inputs from the National Farmers Federation and the Rural Training Council of Australia. In South Australia, the pilot course was conducted in July 1991, by TAFE in liaison with the UF&S. Participants must achieve specified competencies in the areas of legislation, label interpretation, safety, application, IPM strategies and record keeping. Unfortunately the emphasis, duration and assessment of the course varies between States.

Reseller Accreditation

AVCA in conjunction with the South Australian Department of TAFE initiated an Industry Accreditation Scheme for chemical resellers which commenced in 1988. The first part of the scheme involved training industry personnel who sell, advise, recommend, apply or

handle farm chemicals. AVCA anticipated that in three to four years nearly 10,000 industry members could receive accreditation. The second part of the scheme involves the accreditation of premises at which farm chemicals are stored, handled or sold.

In 1990, the scheme was changed with the initial emphasis being placed on storage, handling and transport of farm chemicals. It is anticipated that additional subjects will be available as the program develops.

The SA Department of Agriculture through the Plant Services Division, has placed emphasis on the disseminating of research findings to resellers since 1985 through the medium of annual conferences, (Plant Protection Conferences for Industry).

Aerial Agricultural Industry

The Aerial Agricultural Association of Australia was formed in 1958. The Association's aims are the training of industry personnel, the development of safer and more efficient methods of aerial application of agricultural chemicals and the education of farmers on agricultural aircraft use.

During 1988, some 7.5 million hectares were aircraft treated in Australia with herbicides, insecticides, fungicides, fertilisers, seeds, and baiting for vermin. Specialised tasks such as bush fire protection (fire-retardants) are also undertaken.

Capital investment in the aerial agriculture industry exceeds $60 million. Agricultural aviation employs some 2,000 personnel comprising pilots, field staff, maintenance staff and administrators, a further 2,000 people are employed part-time. The industry utilises 260 special purpose aircraft, supporting vehicles and equipment, together with established aircraft maintenance facilities throughout the agricultural areas of Australia. Agricultural pilots are highly trained and licensed under both Federal and State legislation. No other applicator of agricultural chemicals has the degree of training of aerial agricultural pilots.

Australia's cotton crop, valued at $450 million (1988) and rice crop at $120 million are almost entirely dependent on aerial spraying. Other major crops are dependent on aircraft to a varying degree, often influenced by seasonal conditions.

The incidence of off-target encroachment of chemicals attributable to aircraft is very low by comparison with the number of aerial spraying jobs undertaken. Of the estimated 90,000 jobs undertaken in 1988, there was approximately 40 complaints or 0.4 per cent (AAAA submission to Senate Select Committee on Agricultural and Veterinary Chemicals).

Accreditation for Aerial Agriculture Personnel

Operation Spray Safe is an AAAA initiative commenced in 1985 involving education, training and accreditation of industry personnel.

SADA has had a liaison officer with the AAAA (SA) since 1984. Since 1982 annual Aerial Agricultural Technical Workshops have been convened by SADA (Plant Services

Division). Aside from industry personnel these workshops involve other Government departments including Health, TAFE and the Federal Civil Aviation Authority.

INDUSTRY POTENTIAL

SUMMARY

The greatest area of potential for agriculture is to, as far as possible, reduce its reliance on the widespread use of synthetic chemicals as solutions to pest/disease problems. Agriculture's dependence on chemicals can be reduced by taking advantage of the current interest in non-chemical pest/disease control strategies and by taking advantage of new technologies available to the agricultural and chemical industries. Renewed interest in non-chemical pest/disease control has stimulated critical evaluation of many traditional and organic farming practices and will provide agricultural producers with genuine alternatives to synthetic chemicals. Advances in biotechnology and biochemistry will enable the marketing of new products which are more specific in their action, less toxic and less persistent. The use pattern of the new generation of chemical products will be unlike their predecessors. In the future chemicals will be used in smaller quantities and as part of a whole-farm management plan, instead of as total pest control solutions. Reductions in problems related to widespread chemical use, such as chemical resistance, worker safety and food residues, will follow automatically.

It must be recognised that this is a longer-term vision. In the shorter term it is necessary to address issues which are the result of past practices or which threaten to prevent agriculture achieving its goal. Of these barriers, the funding of research is paramount. Australia is well advanced in its use of biotechnology in agriculture. In the past, most chemical research has been conducted by the chemical industry because they were assured of profits from the sale of new chemical compounds. However, the research required now and in the future will not necessarily lead to marketable products and may therefore fail to attract private sector support. New sources of research funding, or a redirection of existing government and RIRF funded research, will be needed to maintain progress in areas where marketable products are not likely or where there will be widespread community benefit (such as biological control).

The factors making up the overall strategy of reducing dependence on chemicals are set out below. The issues behind these strategies are discussed in detail in the next section of this report.

EFFICIENCY OF CHEMICAL USE

The indirect economic potential of more efficient chemical use is of greater importance than the direct economic benefits. By reducing chemical use the onset of chemical resistance in target organisms is delayed and the potential for residues is reduced. The use of target-specific chemicals may avoid the induction of secondary pest problems, caused when parasites and predators are inadvertently affected.

The direct economic benefits of more efficient chemical use will be in reducing the costs of chemicals used on the farm, the relative importance of which varies between industries. For example, potential savings in broad acre herbicide application by more efficient techniques may result in a proportionately greater benefit than the comparatively small savings possible in some intensive horticultural enterprises. These cost savings may be offset by the increase in technical knowledge required to manage new pest control

systems.

The potential for improved environmental protection and human safety is related to reduced frequency and quantity of chemical application consequent to more efficient chemical use. In the past 20 years, more efficient chemical use has already resulted in a decline compared with previous years in the total amounts of chemicals used by many agricultural industries. Further, the types of chemicals used are less hazardous to health and less likely to accumulate in soil, water and food chains. There is potential for further efficiency in chemical use in a number of agricultural industries by:

- rationalisation of management techniques,
- development of economic thresholds,
- matching chemical use to specific climatic and soil types,
- development of chemical programs for minor use situations,
- improvement in the quality of chemical formulations.

OFF-TARGET EFFECTS

By far the most important aspect of the off-target effects of pesticides is the question of residues in the environment. These residues can result from the regular use of persistent chemicals or from the use of inappropriate chemicals. The removal of registration of some of the organochlorine group has ameliorated the problem to a certain extent and attention is now being directed towards other areas of concern such as heavy metals.

Overall, the increased awareness of the potential for residues coupled with changes in legislation and improved education should reduce the potential for the build up of chemical residues in the environment.

The subject of the disposal of containers and unwanted chemicals is also an important factor and must be addressed as a matter of urgency. The disposal of used containers has not been adequately addressed by government or industry. The introduction of returnable and more easily disposable containers is seen as a very positive step and could provide a model for future directions which could include not only returnable, but also re-useable containers.

High temperature incineration is the only option currently available for the disposal of unwanted chemicals. Research into other forms of disposal (e.g. catalytic or enzymatic) is essential, although the problem of siting any disposal operation will remain irrespective of the process involved. The only certainty is that the disposal of chemicals will be an expensive process.

The subject of spray drift has received wide attention in recent times and was recently addressed by an inter-departmental working party. While spray drift is of some concern it is not a major contributor to the off target-effects of pesticide use. The Spray Drift

Working Party has produced a report and has received considerable public comment. The report recommends the introduction of accreditation and training for all persons applying agricultural chemicals (except home gardeners) and also proposes restrictions on the application of agricultural chemicals within 50 metres of residential zones. These and other recommendations will obviously be widely debated by the community. In the long term, whatever the outcome of this exercise, the problems associated with spray drift should be minimised.

The purity of pesticide formulations is an area of minor concern and obviously contributes to off-target effects of pesticides in some instances. Impurities can include by-products of manufacture, solvents, propellants and surface active agents. Compounds such as dioxin have caused major concern in the past, but recent trends both in manufacture and legislation have been towards the production of purer commercial products and this is likely to continue.

HUMAN SAFETY

There is great potential for improvement in safety aspects of farm chemicals whether it concerns direct toxicity to a user, exposure from off-target applications or from residues in food. Currently the Department of Agriculture, TAFE (through certificate courses), South Australian Health Commission, chemical resellers and the United Farmers and Stockowners (UF&S) have a role in improvement of safety of those people who handle, distribute and apply agricultural and veterinary chemicals. The importance of such education will not be diminished.

We have identified some deficiencies in the design of chemical containers and of safety equipment. Superior products are available but the cost factor is sometimes prohibitive. A concerted effort to influence government policy which affects the cost of safety equipment would be worthwhile.

The joint problems of off-target damage and chemical residues in food were found by the committee to be a major concern to many members of the public. Fortunately the reality is that both represent very little risk to South Australians. Nevertheless, monitoring of both problems should continue. The Department of Agriculture and chemical industry's technical staff can further reduce possible problems in these areas by encouraging:

- use of products which degrade quickly,
- rational use of chemicals in 'balance' with other pest management options,
- dissemination of factual information on the risk to human safety posed by agricultural and veterinary chemicals.

The low levels of pesticide residues in most South Australian produces offers opportunities for marketing at a premium price either as 'organic' grades (if free from chemicals) or 'conservation' grades (if low risk compounds are used).

ALTERNATIVES TO PESTICIDES

In the three decades since the Second World War (so called "Era of Pesticides"), pest control was achieved mainly by the use of chemicals which were relatively cheap, easy to apply and often achieved immediate and spectacular results. Comparatively little effort was put into the development of alternative methods. Since the 1970's research into alternatives to pesticides and integrated methods has accelerated with significant advances in many areas. However there is still huge potential for the development of IPM programs and alternatives to pesticides. As many of the alternatives and most integrated programs must be designed for specific pest/product situations this is no simple task and in many areas requires significant research input.

Physical and Cultural methods: These were amongst the major methods of control prior to the widespread availability of pesticides. Though they are presently widely used often their effectiveness is not fully appreciated and they are not used anywhere near their full potential. Education programs to increase the quality and extent of use of these methods could do much to reduce the use of pesticides. A particular area of potential is in the control of termites, currently the major usage of organochlorine pesticides.

Biological control: Classical biological control has particular advantages as a method in the extensive, low value per hectare, farming systems of Australia where it will often be uneconomic to control with pesticides (for example rabbits, weeds of rangelands). Australia has already had a number of spectacular successes in this area and further research could be expected to lead to similar successes in the future. The use of inundative methods, in particular the so called "biological pesticides" based on viruses, bacteria, fungi and nematodes would seem to have particular potential with some products now beginning to come onto the market.

Genetic improvement in host resistance: In plants in particular this has been a very fertile area in the past and will continue to be a major avenue for the reduction of pesticide usage in the future. Full realisation of the potential of this method requires the use of economic thresholds in determining the timing of pesticide applications. Biotechnology, in particular genetic engineering, greatly enhances the potential advances possible through this means in both plants and animals.

Autocidal control: The major area of success with this method in the past has been by the sterile male technique. Use of this technique to reduce pesticide use in fruit fly outbreaks has potential in the future.

Vaccination: Significant research is being conducted to develop vaccines for the control of animal pests and diseases. Major breakthroughs that could significantly reduce pesticide usage appear some years away.

Eradication Quarantine and Legislative Control: The importance of quarantine and legislative procedures to prevent the entry and/or spread of pests, thereby containing the costs of production, maintaining markets and to reducing pesticide usage, cannot be overstated. There appears to be limited opportunity for the eradication of endemic pests.

EDUCATION AND INFORMATION

Education and training are consistent themes throughout this report. Measures to educate and train those handling and using agricultural and veterinary chemicals are integral to achieving judicious chemical use in Australia. Measures to educate consumers and the general community are integral to maintaining faith in the quality of Australia's agricultural produce.

Education and training measures have the potential to:

- increase the safety of chemical users and handlers,
- prevent chemical residues in food or in the environment,
- reduce overall use of chemicals in agriculture by promoting a more judicious use of chemicals and increasing the use of integrated and alternative methods of pest control,
- create a greater understanding of the role of chemicals, and the risks and benefits of their use or non-use.

Much of the knowledge needed to achieve these goals already exists in one form or another. Education and extension have the capacity to make this knowledge more widely understood and adopted into farming practices.

Chemicals and their uses are complex subjects requiring varying degrees of expert knowledge. Farmers and advisers must make sense of a huge and sometimes bewildering array of chemical and non-chemical products and methods. At present, the general community must make do with whatever information they are able to find, and at times their only information comes from sensational reports made by non-experts. Measures which foster an understanding of the place of chemicals in agriculture, the risks and benefits of their use, and the system which regulates the use of chemicals, have the potential to bring balance to the debate on the appropriate role and level of chemical use in Australian agriculture.

Ensuring that information is available on chemical compounds, toxicity and residue survey results will ensure that all sectors of the community have access to accurate, unbiased information. Modern awareness of science and sense of responsibility for health and environmental care demand that more information is made available as well as seeking readier access to experts and regulatory authorities. Technology is now available to make large amounts of information available in a manageable, even portable, form. Information can be tailored to the needs of users, be they advisers, farmers, students or members of the general community. 'Chemical specialists' could be made available to support farmers and other specialist agricultural advisers by providing up-to-date advice on chemical and non-chemical solutions to pest and disease problems.

LEGISLATIVE ASPECTS

By world standards, Australia already has quite a comprehensive system regulating the use of agricultural and veterinary chemicals. Nevertheless, initiatives are underway to address or strengthen a number of specific areas, such as the assessment of genetically manipulated organisms, uniformity of regulation, and the control of off-label use of chemicals. These initiatives have the potential to provide an Australia-wide chemical regulatory system based on up-to-date knowledge and technology, whilst maintaining the responsiveness of the system to the needs and views of all sectors of the community.

Part of the process of strengthening and rationalising regulation must be to take account of the distortions that can be created by the regulations themselves. The greatest of these distortions at present is the economic cost, and therefore commercial reluctance, of bringing off-patent products, off-label and minor uses of chemicals more fully under regulatory control.

Ongoing devotion to building a comprehensive, efficient and accessible Australia-wide arrangement for regulating chemicals, will ensure that agricultural enterprises continue to have access to chemical products, consumers and the environment are protected against the misuse of chemicals and that the quality and of Australian agricultural produce is recognised in Australia and the world.

MARKETING OF AGRICULTURAL PRODUCE

Agricultural industries will only survive by getting market access and acceptance, that is by producing what consumers want. It is important that feedback mechanisms provide the grower industries with the latest market information, including trends and projections of future needs. Given that the value of exports to South Australian agriculture is in the order of 65% of total production, international market intelligence is of vital importance.

Consumers worldwide are concerned about chemicals in food, not only from the point of view of their health effects but also because residues in food imply a widespread use of chemicals which may have unknown long term effects on the environment. Chemicals in food becomes a focus for larger environmental issues. International exchange of information between consumers on food safety issues occurs rapidly and it is important that Australian agriculture is able to respond quickly to consumer demands.

However, not all concerns of consumers are shared by all governments, farming and chemical industries. Various initiatives within food safety and consumer education are happening: State governments are considering, planning or implementing public educational campaigns while tightening regulatory controls, the chemical industry is promoting the US FoodWatch program with the aim of trying to establish a similar program in Australia and a number of farmer organisations and marketing authorities are adopting a more proactive approach to forming a bridge between producers and consumers.

There is a need to co-ordinate these activities to ensure consistency in messages and profile and a constant flow of information and feedback. The expression of consumer

concerns will not diminish in the future and will represent a challenge to farming industries to adapt to the changing attitudes of consumers in order to prosper. The reward will be continued ability to market good agricultural produce and achieve a higher level of consumer preference.

ISSUES, OPPORTUNITIES AND BARRIERS

INTRODUCTION

A number of terms are used throughout this section of the report as short-hand methods of referring to whole groups of chemicals or technologies. Two particularly important terms are 'pesticide' and 'integrated pest management' and the following explanations of these two terms should be kept in mind. Definitions of other technical terms used in this section can be found in the glossary on page 113.

A pesticide is a substance or agent which is used to destroy or control any form of unwanted plant, fungal, insect or animal life. The term pesticide therefore includes a large proportion of both agricultural and veterinary chemical products. Insecticides, herbicides, anthelminthics, miticides, fungicides and antibiotics are all types of pesticides.

Integrated pest management (IPM) is a pest management system that utilises a variety of techniques and methods in as compatible a manner as possible to keep pest populations at tolerable levels, given the associated environment and the population dynamics of the pest species. Techniques may include a mix of biological control (eg. introduction and conservation of natural enemies), plant or animal resistance (eg. aphid resistant lucerne cultivars, tick tolerant cattle), environment modification (eg. controlled atmosphere grain storage, mulesing of sheep) often with synthetic chemicals timed to complement these other methods. The opposite of IPM is calendar application of broad-spectrum chemicals; this method was used almost exclusively against insect pests of agricultural, medical and veterinary importance in the DDT-organophosphate era of the 1940s to the 1960s. The chemicals were applied whether or not they were needed at times not necessarily related to the most vulnerable stages of the target pest.

EFFICIENCY OF CHEMICAL USE

Integrated Pest Management (IPM)

The overall issue:

Reliance on chemicals as the only method of pest control in a particular agro-ecosystem generally results in more chemical being used than if chemicals are integrated with other methods of control. These methods include conservation or introduction of natural enemies, breeding resistant plants or animals and environmental modification (see section on alternatives to chemical on page 69).

Overuse of chemicals has resulted in resistance in many target and non-target pests. Overuse of chemicals also results in greater environmental or health hazards than are necessary. Use of inappropriate chemicals may cause greater ecological disturbance than necessary.

There are a number of well established I.P.M. programs presently operating in South Australia for insect control in citrus, stonefruit, pomefruit and seed lucerne crops, and for helminth control in sheep (Wormcheck). The research for these programs has been undertaken by public institutes, particularly the S.A. Department of Agriculture, the Waite Institute and CSIRO. Subsequent servicing of these programs has been undertaken by private crop monitors and an insectary.

The technology of IPM requires precise identification of the target pest, a good knowledge of its biology, an understanding of how natural enemies and the environment regulate its numbers, and the relative susceptibility of the pest and its natural enemies to pesticides. An accepted density threshold, or economic threshold, below which the pest can be tolerated is also needed (see also page 49).

One result of IPM is that the need to use pesticides is reduced or, in some cases, eliminated. This in turn slows the development of resistance (by either the target pest or unintended 'secondary pests') and also reduces environmental contamination and health hazards. However, for many IPM programs, some chemical intervention is necessary when pest numbers exceed tolerable levels.

Opportunities:

- Development of I.P.M. programs for other significant agricultural pests.
- As they become available, innovations in target-specific pesticides should be integrated into I.P.M. programs. These include insect growth regulators, pheromones, insect pathogens and biological control agents.
- Development of economic thresholds for more pests and diseases.
- Further establishment of industry-based pest management monitoring services.

Barriers to achievement:

- Research on non-chemical methods of control relies heavily on government finance since neither chemical companies or agricultural industries perceive sufficient benefits from funding such work.
- Slowness of many farmers to adopt I.P.M. technology.
- Scarcity of I.P.M. monitors and entrepreneurs to service a number of industries.
- Unwillingness by small industries, who use a disproportionately high quantity of chemicals, to pay for specialist services.
- Unwillingness of the chemical industry as a whole to support strategic research (as distinct from product registration trials) on integration of pesticides into management programs based on low chemical use.

Pesticide Activity

The overall Issue:

Broad spectrum pesticides are developed and marketed by the chemical industry because they have greater market potential than pesticides with a narrow spectrum of activity. While there have been few reports of major ecosystem disturbance caused by the use of broad spectrum herbicides and fungicides in Australia, the use of broad spectrum insecticides has disrupted a number of agro-ecosystems. Broad spectrum insecticides kill not only the target pest but also natural enemies, and may favour the development of resistant strains of non-target pests. Selective insecticides (narrow spectrum insecticides) are additive to the action of natural enemies of pests and do not induce resistance in non-target pests.

Herbicides, while having a degree of specificity, remain broad spectrum. The important trend in herbicides is the decrease in mammalian toxicity of modern herbicides (see Industry Statement). In the case of pesticides for vermin control, much research is being directed towards the selection of bait material and method of use to minimise off-target damage.

Selective pesticides are useful in most pest control situations but are particularly relevant to IPM programs where timed applications of synthetic chemicals are used to complement other non-chemical control strategies. Selective pesticides usually are more expensive than broad spectrum pesticides and may not be as effective as broad spectrum pesticides.

Opportunities:

- The wider adoption of IPM programs would increase demand for narrow spectrum pesticides and therefore increase the profitability of research and development of narrow spectrum products.

Barriers to achievement:

- Use of selective pesticides may require higher levels of technical competence than the use of broad spectrum insecticides.

Resistance to Chemicals

The overall issue

The increasing cost of developing and registering new chemicals means fewer, more expensive chemicals in the future. The effectiveness of those chemicals currently available must be prolonged. The development of resistance to chemicals by agricultural pest and disease organisms threatens to terminate the usefulness of many chemicals. Resistance has been reported to most major pesticide groups, including fungicides, herbicides, insecticides, anthelminthics, antibiotics and rodenticides.

Development of resistance to new chemicals has increased because many pests resistant to old chemicals are cross-resistant to new chemicals. For some pests there are now few, if any, effective chemicals. The development of resistance, more than any other factor, has forced the questioning and alteration of traditional patterns of chemical use. Very little monitoring is done for the onset of resistance in most pests.

Once resistance has been induced, it is necessary to implement more complex patterns of chemical use by alternating chemicals from different chemical families for which there is not pest cross-resistance (useful mainly with fungicides) or applying mixtures of two pesticides with different modes of action, for which there is not cross-resistance. The development of resistance can only be prevented by reducing the frequency or concentration of exposure of pests to chemicals.

Opportunities:

- Reduce exposure of pests to chemicals by using alternative or integrated methods.
- Extension or educative measures to promote adoption of resistance prevention strategies on farms (for example, the WEED-SMART program).
- Modifying dose rates of chemicals before resistance can occur: in some circumstances, a low dose will prevent resistance whereas in others a high dose rate prevents resistance.
- Maintenance of non-treated pest populations.

Barriers to achievement:

- Research into the genetic and biochemical basis for resistance is needed for many pest/chemical combinations.
- Some alternative methods of control may also have problems with resistance. For example, forms A′, B, C and C′ of skeleton weed are resistant to biocontrol rust.

Economic Thresholds

The overall issue:

An economic threshold for pest and disease control is that level of disease or pest infestation which, if not controlled, will result in economic damage to crops and livestock. The concept accepts the idea that some level of disease or pest activity may be tolerable and also that the economic impact of pests and disease is not only related to their numbers or severity but to the cost of control and the value of the crop/animal, both of which may vary from year to year.

Research undertaken for clearance and registration purposes generally requires a high level of control in order to prove efficacy of the product. In practice, it may not always be necessary to achieve the same high level of control on the farm.

Economic thresholds of pests for a number of South Australian crops are presently in use, but for many agricultural commodities no reliable thresholds exist. The reason for the lack of economic thresholds is that the data on damage and yield is often technically difficult to obtain. A number of biological interactions may be involved (as between grasshoppers and sheep on pasture growth); damage may be indirect (as for the effects of mite feeding on apple leaves on fruit yield); plants may compensate for certain levels of injury (as with the feeding of light brown apple moth on grapevines).

Economic thresholds play an important role in IPM programs and other chemical reduction strategies. The use of economic thresholds can help to prevent the onset of chemical resistance in pest species by ensuring chemicals are only used when needed to prevent severe crop damage.

Opportunities:

- The establishment of economic thresholds for more agricultural commodities.
- Where economic thresholds can be established, there may be potential for chemical products to be used at lesser rates/concentrations or at less frequent intervals than are given on product labels, providing a more economic use of the product and without significant loss of efficiency or risk of resistance problems.

Barriers to achievement:

- Funding is needed for research into economic thresholds and into any possible reductions in chemical rates/concentrations. It is unlikely that chemical companies would be willing to fund such research since it may well reduce overall chemical use. Agricultural industries may be willing to fund the necessary work through RIRF's where significant gains in the cost effectiveness of pest control can be assumed.

Application technology

The overall issue:

The usefulness of chemical control of pest populations and disease organisms requires the selection and use of the correct product, applied at the correct time and at the correct rate. Application equipment is vital to this process since even the best chemicals will not work if they are not applied properly. Though extensive data must be provided by chemical companies to demonstrate efficacy before a compound is registered, no such review mechanism exists for application equipment. This is a problem for both chemical companies and the users of chemicals since if poor results are achieved it is usually the chemical that gets the blame.

Target pests can include insects, bacteria, viruses, weeds, vertebrates and others. The aim of all application activities is to bring the active ingredient into contact with the target pest at the appropriate concentration. By increasing the efficiency of bringing chemical ingredients into contact with the target pest, improved chemical application technologies have the potential to reduce the quantities of chemicals used and reduce the likelihood of exposing non-target species to the chemicals.

Opportunities:

- Substantial technical improvements have been made in pesticide application equipment. Continued research and the widest possible adoption of new technology would enable the benefits of the technology to be realised, both in reduced chemical application and lower ongoing chemical costs.

- Quality control measures for application equipment. These could be managed by a system of industry self regulation.

Barriers to achievement:

- As new application technologies become available, chemical dose rates may need to be amended (usually lowered) to account for increased efficiency in bringing the active ingredient in contact with the pest. The research needed to establish new dose/concentration rates is not costless and it is not clear who should pay for the necessary research.

Controlled release technology

The overall issue:

In recent years there has been increasing interest in the use of controlled release technology in many areas of pest control and fertiliser application. Whereas traditional methods of application depend for prolonged action on a single initial high level treatment so that control is maintained until concentrations decay below effective levels, controlled release systems aim to release chemicals in steady amounts at active levels, or to release only at time of infestation. The approach has significant advantages which include:

- prolonged action,
- doses need not be as large, consequently there is reduced chance of chemical residues,
- lower risk to the operator,
- can be used to deliver rapidly broken down chemicals and therefore reduce the likelihood of environmental contamination,
- reduced risk of sub-clinical toxicity, phytotoxicity or accidental poisoning of animals,
- can be designed to reduce the likelihood of pesticide resistance - for example: systems which maintain insecticides at high concentrations and then give rapid residue decay; systems containing rapidly degraded pesticides which release only at time of pest risk; incorporation of families of pesticides that would otherwise be unsuitable for use, thus enabling more effective rotation of pesticides to retard the development of resistance.

Opportunities:

- Increased development and use of controlled release technology.

Barriers to achievement:

- Cost of research and availability of expertise.

- Controlled release formulations are often more expensive and therefore users would need some incentive to adopt this technology.

Research into chemical use in different climatic/soil regions

The overall issue

Many of the pesticides used in South Australia require regional evaluation to determine or refine their optimum use under South Australian conditions. An example is the sulfonyl urea herbicides which have low residual value in high rainfall, acid soil areas but which have such extended residual activity in low rainfall areas with calcareous soils, that they can modify the crop sequence and whole farm plan. Regional evaluation is more important for agricultural chemicals than for veterinary chemicals.

Regional evaluation is often not considered worthwhile by chemical companies since regional chemical sales are not guaranteed or will not offset the cost of the trials. Regional evaluation has therefore been a task for the Department of Agriculture. "Fine-tuning" of dose rate, timing, and application method for particular target pests in particular conditions found in South Australia usually requires cooperation between chemical companies, resellers (with their expanding agronomy staff), departmental staff and farmers. Industry liaison, such as organised by the Plant Protection Group, is invaluable in these situations.

Opportunities:

- Regional evaluation of new agricultural and veterinary chemicals can optimise the use of chemicals by ensuring that the chemical is used most efficiently and effectively under South Australian conditions.

- It may be possible to undertake regional trials on a fee-for-service basis for chemical companies or agricultural industries.

Barriers to achievement:

- The cost of regional evaluation experiments may make them unattractive for some chemical products unless economic gain is assured.

Labelling of chemical products

The overall issue:

The label on a farm chemical product is the primary means available to the manufacturer for communicating information about the product to the user. Information provided on labels is determined by legislation in each State and by the adoption of the recommendations of the National Health and Medical Research Council (NH&MRC), the Agricultural Chemicals Advisory Committee and the Veterinary Chemicals Advisory Committee. Labels are legal documents and must be registered with State and Territory authorities.

Label information includes:

- poison schedule
- intended use of product
- directions for use
- safety directions & first aid
- net content
- distinguishing name
- active constituents and solvents
- protective warnings
- name & address of manufacturer

Product labels have been criticised for a number of reasons including the volume of information printed on labels, terminology used, and the assumption that the user possesses certain skills and understanding (such as the ability to read English).

Opportunities:

- Improve labelling of agricultural and veterinary chemical products. AVCA has already established a task force to develop recommendations for improvements in product labelling. AVCA intends that these recommendations be passed on to industry and government.

- Standardise labelling between Australian States and Territories. The development of a national system of chemical registration would greatly assist the achievement of standardising labelling.

Barriers to achievement:

- Much information on labels is determined by law and required by non-agricultural authorities such as the NH&MRC. Changes to labelling will therefore require the involvement of these authorities and may be hampered by the need for legislative change.

Off-label use of chemicals

The overall issue:

An 'off-label use' is the use of a farm chemical in any way at variance to the instructions given on the product label. This can include different target pests, different host crops, mixtures with other chemicals, higher or lower rates, different frequencies of application and/or growth stage of application. In some states it is an offence to use a product other than according to the label directions. Damage brought about by off-label chemical use may create problems of liability if advice was given to use the chemical off-label.

South Australia's farm chemicals legislation was originally designed to register agricultural and veterinary chemicals (following State/Commonwealth clearance). It was not designed to control use or misuse of chemicals although amendments under the Act in 1987 provide powers to prohibit unauthorised uses of agricultural chemicals. It has only been possible to proclaim these amendments to ban the agricultural uses of certain persistent chemicals. Otherwise the Agricultural Chemicals Act and Stock Medicines Act provide few controls over chemical use and do not extend to controlling the application of all agricultural chemicals.

Agricultural chemical products are registered for a specific purpose under specific conditions. Because of the costs included in generating registration data product development is concentrated on major crops and/or uses. For many minor uses there may be limited data available to establish efficacy or the maximum residue limits required for registration, and small chemical sales may mean that registration is not a profitable venture for the company.

The intensive farming of fish and crustaceans for food is an expanding industry in S.A. and Australia generally. An aquarium fish industry has existed for many years. Chemical use in aquaculture is widespread, however there are currently no chemicals registered in South Australia for use on food producing fish. Two products have been cleared recently but are not yet registered. A number of products are registered for aquarium (ie. non-food producing) fish. Pest problems will be treated with substances in a 'best bet' fashion or on anecdotal evidence in the absence of registered products with a consequent potential for serious mishaps to occur.

Opportunities:

- Examine the regulatory approach to the minor use of agricultural and veterinary chemicals and develop a national minor use program as recommended by the Senate Select Committee in its report on Agricultural and Veterinary Chemicals in

Australia (July 1990).

- Promote research into minor uses of agricultural and veterinary chemicals so that such uses can be registered. Strategies can involve:
    - Undertaking contract research work for chemical companies on a fee-for-service basis.
    - Some research, especially into minor chemical uses of off-patent products, could be undertaken by the Department of Agriculture on "common good" basis.
    - Research is already undertaken by the Department (eg. by Plant Protection Unit), on minor crops as part of regional programs where these uses are considered a priority. It may also be possible to collect some data during other research involving chemicals.
    - Funding of priority areas by rural industry research funds (RIRFs) or other industry groups.
- Encourage and expedite registration of chemicals for use in aquaculture.

Barriers to achievement:

- The cost of conducting the research may make the work unattractive unless economic gain is assured:
    - The chemical industry does not financially support work on integrating chemicals into other pest or disease control systems, other than for product registration purposes.
    - RIRFs may not recognise this work as a priority for funding or may not be willing to fund research that they perceive should be funded by others.

Quality Assurance of Formulations

The overall issue:

The provision of ineffective or damaging formulations of agricultural or veterinary chemicals has the potential to reduce agricultural production significantly or to create public health, environmental or trade problems. Purchasers expect that chemical products will be effective when used according to directions.

Poor quality products may arise from:

- inappropriate choice of active compound(s) for the advertised purpose;
- too high or too low concentration of active ingredient present in the product

- ineffective formulation for delivering the active ingredient
- presence of contaminants either from the breakdown of the active compound or from the mixing or packaging of the product.

These days the health, safety, trade and environmental aspects of assessing chemical products tend to dominate clearance and registration. It must be recognised that purchasers of chemical products continue to want assurances about the quality and efficacy of the products they buy and that complaints about the quality and effectiveness of products will continue to be brought of the attention of the Department of Agriculture. The Department is often perceived as an impartial body able to investigate and take action against sub-standard products or fraudulent claims.

Opportunities:

- Potential to develop industry self regulation of some aspects of quality control, for example, the presence of contaminants or concentrations of active ingredients.

Barriers to achievement:

OFF-TARGET EFFECTS

Disposal, re-usage and storage of chemicals and containers

(1) Containers

The Overall Issue:

Used pesticide containers pose an environmental hazard, firstly by the sheer bulk of the waste generated and, secondly, where containers are not adequately rinsed after use.

The recycling of chemical containers is not always possible because of the legislative requirement for containers to be destroyed after use. A number of companies have introduced environmentally responsible packaging which has often involved the use of new technology. The new packaging is either reusable or is made of material more suitable for disposal.

The matter of the rinsing of containers and disposal of empty containers has been addressed in part by the Waste Management Commission with the production of a fact sheet.

A working party has been established by the Minister of Environment and Planning on unwanted pesticides and pesticide containers. A number of interested parties are involved on the working party from both government and non-government areas. The working party will report on a preferred approach to the safe disposal of pesticides and containers.

Opportunities:

- More chemical companies should be encouraged to use returnable or refillable containers.
- Councils be encouraged to organise and publicise drum crushing days.
- Promote suitable alternative uses for used containers e.g. as tree guards.
- Educate chemical users about the environmental hazards of unwanted pesticides and their containers.

Barriers to Achievement:

- There will be some increased costs associated with returnable containers or organised disposal.

(2) Chemicals

The Overall Issue:

There is no formal process for the disposal of unwanted or excess chemicals. Even if a regular recall program existed for chemicals, there is no adequate disposal facility in Australia for some of the intractable waste that would be collected.

Opportunities:

- The establishment of a regular chemical recall program to reduce the hazard presented by long-term storage of unwanted chemicals on farm.

- To encourage State and Commonwealth Governments to address the question of disposal of intractable waste as a matter of urgency.

Barriers to Achievement:

- The cost of an ongoing recall program is somewhat unknown and the question of "who pays" is also unresolved.

- The major barrier to the establishment of a suitable disposal facility is the identification of a site that is acceptable to the authorities and the community. There is widespread support for the establishment of a facility, but "not in my backyard".

(3) Storage

The Overall Issue:

While there is legislation in place related to the storage of large quantities of chemicals (the Dangerous Substances Act), there remains a concern about the adequacy of many storage facilities, particularly on farms and in the home garden.

Opportunities:

- The establishment of an education program for both the rural and urban communities to encourage safe storage of chemicals.

Barriers to Achievement:

- Lack of resources to mount an education program.

- Existing legislation and guidelines are extremely complex making it difficult to comprehend what storage arrangements should be made and discouraging people from complying with the regulations.

Residues in the Environment

The overall issue:

Environmental contamination often stems from repeated exposure to persistent chemicals where the rate of accumulation exceeds the rate of decomposition. Persistent chemicals have a use in situations where frequent application is not possible or desirable. Some chemicals are persistent on the host organism but degrade in soil and groundwater, or are metabolised in mammals. Persistent chemicals which do not degrade in soil or water, or are not metabolised by mammals, accumulate in food chains and may present a hazard to humans. The most persistent chemicals are some chlorinated hydrocarbons (eg. dieldrin). The only registered use of chlorinated hydrocarbon insecticides in South Australia is for dieldrin, aldrin and heptachlor for termite control.

Heavy metals, such as mercury or cadmium, are also of concern since they do not decompose and can lead to serious contamination levels.

Residues of a chemical or therapeutic substance in the environment can have unwanted and deleterious effects on unintended targets. Recent examples of this phenomenon include

- organochlorine pesticide residues in crops and soil causing violative residues in meat.
- arsenic residues in soil from use of arsenic-based sheep dips causing violative residues in wool several years after their last use.
- pesticide and herbicide residues having residual effects on non-target species of flora and fauna.
- residues of agricultural chemicals affecting the utilisation of other seemingly unrelated natural compounds and elements.

Pollution of water bodies is a particular case of residues in the environment. Water is a means of transporting a residue a long way from its original source and is also a means of concentrating residues from a large catchment area. It is possible for water pollution to occur even when the person using an agricultural or veterinary chemical believes that steps have been taken to prevent pollution. Used containers in dumps are a particular risk to water courses and the water table. Nutrification of water supplies (underground and run-off) can be brought about by widespread fertiliser use in a particular area.

This issue is one of widespread community concern. Some of the concern is misplaced and some concerns are inflamed by sensational reporting. In many cases residues arise from inappropriate or incorrect use of a chemical or drug, many of which are freely available to the public. The principal means of reducing environmental residues will come from continuing education in the responsible use of drugs and chemicals.

Opportunities:

- The current trend in developing more target specific products provides opportunities for the chemical industry to reduce product persistence (except for specific products where longevity is required e.g. termiticides).

- The development of more target specific products could be supported by Government by providing economic incentives for short-lasting products with reduced risks for environmental contamination or economic disincentives for unnecessarily persistent products.

- Greater understanding of off-target, and long term, effects of certain products is needed to identify risk factors and appropriate contamination prevention strategies.

- Eliminate the remaining uses f persistent organochlorine chemicals by developing alternative controls for termites in buildings. Current proposals include pathogens and pheromones or the integration of a number of control methods e.g. abrasive dust foundations, steel frame construction.

Barriers to achievement:

- The initiatives above may incur an additional cost which may have to be carried by the product and/or be passed on the user.

- Sometimes the cause of contamination cannot be attributed to a single source. It may be necessary for the cost of removing the contamination to be shared between industry and Government.

Spray drift and chemical trespass

The overall issue:

Spray drift, or chemical trespass, is the movement of a chemical outside the target area. This can occur during or after application. Airborne chemical drift (spray drift) includes droplet or particle drift (direct wind drift, thermal drift, immersion drift) and vapour drift. Chemical trespass can also occur after application, by water leaching and soil particle movement.

Spray drift and chemical trespass may have a number of consequences, including:

- monetary loss to the user because the chemical is not placed on the target area

- poor pest control and subsequent crop loss

- damage to desired vegetation and crops and to non-target organisms

- contamination of other agricultural produce and of non-target areas, including water bodies and buildings

- human health hazards

Assaying techniques are not always sufficiently rapid, cheap, reproducible and available to enable rapid measurement of residues in suspect situations.

Opportunities:

- Consideration and implementation of the recommendations of the Review of Agricultural Spray Drift discussion paper (March 1991).

Barriers to achievement:

- Public perceptions and pressures.

Chemical Purity

The overall issue:

Chemical formulations are becoming increasingly sophisticated. The chemical formulation is the mixture of active and non-active ingredients needed for delivering the active chemical to its target in a plant or animal.

The active ingredient may be accompanied by any or all of the following:

- solvents,
- surface-active agents,
- colours or perfumes,
- propellant gas (for aerosols),
- architectural molecules (forming the cage in which the formulation resides),
- impurities from manufacturing the active chemical.

The off-target effects likely to arise from such non-active ingredients are generally highly localised and may be responsible for minor health effects to a user if appropriate protective measures are not taken, for example contact dermatitis from kerosene solvent. Freon propellants have undoubtedly contributed to ozone depletion in the upper atmosphere.

Manufacturing impurities may occasionally present serious environmental and occupational health problems, for example:

- dioxin (i.e. 2,3,7,8 TCDD) in the herbicide 2,4,5 T
- high volatile 2,4-D esters in low volatile formulations
- malaoxon in the insecticide malathion.

More subtly, the presence of chemical compounds which are isomeric with the active ingredient yet which are biologically ineffective means they will be unnecessarily mobilised into the environment.

Pressure is mounting in the EEC to legislate so formulations contain only active isomers. This change is being welcomed most by countries with sophisticated chemical industries, like Switzerland, who are able to manufacture stereochemically - pure active compounds.

Opportunities:

- Scope exists for greater use of solvent free chemical formulations.

Barriers to achievement:

- With present technology, it is not possible to concentrate active ingredients as much in solvent free formulations as in those using solvents. This means less concentrated chemicals in bulkier packaging with consequences for transport, storage and disposal.

HUMAN SAFETY

Toxicity and persistence of farm chemicals

The overall issue:

Toxicity is the degree to which a substance is injurious to a plant or animal. Toxic effects can be divided into **acute** or short term effects that occur soon after exposure to the substance and **chronic** or long term effects. Long term toxic effects can include carcinogenesis, mutagenesis, teratogenic effects and behaviour modification. A substance may be persistent and accumulate in body tissues or it may be rapidly metabolised or excreted and not accumulate. More important than the toxicity of a given chemical is the **hazard** from it. The hazard is a function of two factors, the toxicity of the substance and degree of exposure to it.

All pesticides are exhaustively tested for both acute and chronic effects on humans before registration. No pesticide will be registered for use in ways which would represent a significant hazard to humans.

Currently there seems to be a perception in the community that the use of all synthetic pesticides is bad and that the presence of residues of any sort is unacceptable. This is leading to significant resistance within the general community to the use of any chemical methods of pest control.

Opportunities:

- Initiatives to educate the community regarding relative risk of chemicals.
- Initiatives to increase public awareness of the registration process and the extent of assessment undertaken to ensure safety before a chemical is registered.
- Promote the development of chemicals which are less toxic to humans and less persistent, as well as promoting the adoption of integrated and alternative pest and disease control methods.

Barriers to achievement:

- Difficulties in providing proof of safety.
- Reporting of emotive and unsubstantiated claims often made by unqualified people exacerbates community fear and distrust

Misuse of chemicals

The Overall Issue:

Chemical misuse may occur for various reasons:

- Ignoring label instructions, including off-label chemical use in some cases,
- Inability to understand label directions due to educational background, non-English speaking background, or because of poor label design,
- Use in adverse or inappropriate weather conditions,
- Wilful misuse, for example the use of an insecticide or veterinary medicine as a poison bait,
- Lack of an effective and legal solution to a pest or disease problem.

Although the action taken in response to incidents of chemical misuse will vary according to circumstances, the facility should exist to prosecute repeat offenders and in extreme instances of chemical misuse. There is presently little proper authority for Departmental officers to investigate and to take corrective action or to prosecute repeat/extreme offenders. Some powers will exist under the new Stock Act to deal with residues in stock.

Opportunities:

- The education of both resellers and users, plus the improvement of label information, can be a most effective way to reduce the misuse of chemicals. Particular consideration should also be given to users from a non-English speaking background.
- The problem of off-label and/or illegal use can be largely overcome by attempting to provide a registered use to address each pest/disease problem.
- Access to label information by extension staff to ensure that questions about chemical use can always be answered quickly and accurately.

Barriers to Achievement:

- Label information is subject to rigid guidelines issued by government authorities and the ability of either chemical companies or State agencies to improve the label information is very limited.

Chemical use in home gardens and residential situations

The overall issue:

Many of the chemicals used in agricultural production are also marketed for domestic use

in and around homes, schools, parks, and gardens. In addition, there is a large range of chemicals specifically designed for domestic use, such as pet supplies and home garden products.

Chemical products, sometimes very hazardous, are readily available in supermarkets, chain stores, and garden centres. Many products are also marketed and packaged for convenience, for example liquid fertilisers and lawn weeders dispensed by attaching to a garden hose. These practices may lead to overuse and to storage/handling problems. Often less toxic alternatives are available. For example, the organophosphate chlorpyrifos is widely used as an insecticide and could be replaced with the less toxic pyrethroid permethrin.

The ease of availability of chemical products is regulated by poison scheduling and related legislation (in S.A. the Controlled Substances Act, 1984). Further non-legislative measures can be used to enhance the effectiveness of poison scheduling by preventing the unintended misuse of chemical products.

Although public focus is usually given to agricultural not domestic uses of chemicals, issues associated with the safe handling, storage, use and disposal of chemicals in domestic situations are equally important. There is a similar risk of overuse, spray drift, or contamination of beneficial plants or pets. When used domestically, chemical products are not handled and applied in large quantities or applied over large areas at a time. Nevertheless, the density of urban living means that there may be a greater risk of accidental exposure to chemical hazards.

Opportunities:

- Special attention should be given to the question of whether certain particularly hazardous substances should be readily available for home use.
- Public education on chemical matters can make a connection between the risks and benefits of chemical use generally and the chemicals used in homes and gardens. Similarly, the urban population should be educated about the safe use of chemicals.
- Develop a code of practice for the manufacture and packaging of products for domestic and urban use.
- Accreditation or training for persons giving advice on chemicals for use in domestic situations.

Barriers to achievement:

- A comprehensive review of all products already available for domestic use would be a time and resource consuming process. It should be noted that the availability of certain chemicals is reviewed as necessary or when opportunity allows.
- Increased regulatory impact of any action to limit products marketed for home use and their packaging.
- Possible public resistance to loss of some products for home use.

Residues in Food

The overall issue:

The possible presence of chemical residues in food often causes concerns among the general public that such residues will be hazardous to health. Residue surveys indicate that Australian food contains negligible amounts of chemical residues and that health standards are adequate. Nevertheless health standards need to be maintained to protect the public against future chemical use patterns which may impose a real health risk.

The Australian Science and Technology Council in its report "Health, Politics, Trade - Controlling Chemical Residues in Agricultural Products" stated: *"... chemical residues in agricultural products are not an undue hazard to consumers of Australian agricultural produce, and that Australian and international regulation and enforcement standards are sound"* (p 1). This clearly demonstrates a contemporary dilemma between public opinions and scientific facts on the safety aspects of chemical residues. There is also a growing preference in the community for natural or 'organic' products.

Concern regarding the use of chemicals often occurs after the publication of data showing residues of chemicals have been detected in foodstuffs. As methods of analysis improve and become more sensitive, the detection of residues at smaller and smaller concentrations becomes more certain and so technology is indirectly fuelling public concern.

The ability to establish monitoring/surveillance programs with traceback of violative residues to properties of origin is the most cost effective and efficient method of satisfying domestic and export requirements and to enforce compliance with residue limits. Considerable success and international acceptance has been gained with the National Residue Survey (NRS), National Antibiotic Residue Minimisation (NARM) and hormonal growth promotant programs run through abattoirs.

Cheap, easily used diagnostic and analytical kits for the detection of chemical residues in plant and animal tissues may, in the near future, provide the primary means of avoiding contaminated food coming to market. They will also assist producers in experimenting with different cultural/treatment regimes. On-farm test kits would also enable producer-sources of residues to be detected by regulatory authorities and thereby provide a direct disincentive for chemical misuse.

Opportunities:

- Relatively low volumes of chemicals are used in South Australia due to the fact that the state has fewer pest problems. This may provide an opportunity for marketing SA produce as chemical free. It is also an advantage when it comes to reducing chemical use.

- The tendency for increasing sensitivity in chemical analysis to add to public concerns is best broken by:

- establishing unequivocal toxicity thresholds for pesticides
- moving to low-pesticide-use agriculture with compounds which degrade rapidly in the environment.

- Establishment of monitoring or surveillance programs for horticultural produce, including traceback to property of origin. There is potential for monitoring grain delivered to bulk handling/storage facilities.

- Increased co-ordination between interstate residue monitoring results so that the public can be better informed of the residue status of Australian produce.

- Marketing of diagnostic and analytical test kits to producers and training courses in their use.

- Increased public awareness of residue trace back programs and results can improve agriculture's image and gain public recognition that the Department cares about food safety and is able and willing to do something about it.

Barriers to achievement:

- Complexity of toxicological parameters and the difficulty of ensuring public understanding of their significance.

Safety Equipment

The overall issue:

Achieving improvements in the availability, cost, design, quality and use of safety equipment is an important part of increasing the level of operator safety. The education of applicators in the hazards of agricultural chemicals and the correct use of safety equipment is vital, but will be in vain if safety equipment is not readily available in designs that are useful and at a price that is affordable. Farmers find that chemical containers are of variable standard, ranging from ideal to those with which it is almost impossible to avoid spillage and/or splash. This places extra emphasis on protective clothing. Respiratory protectors are often uncomfortable and short-lived. Full head protectors and advanced filtering systems can be so expensive as to be beyond the means of most farmers and spray contractors. The ideal solution to respiratory protection is probably to filter the application vehicle's cabin, but this is expensive. There have been recent advances in the overall quality and availability of a wider range of both safety clothing and respirators. Some operators believe that modifications to taxation laws which would reduce the cost of safety equipment are required, rather than the current emphasis on penalties under workers compensation acts.

Opportunities

- Policy initiatives which influence the cost of safety equipment will encourage greater use of the equipment and could provide incentives for design

improvements.

- Improvements in container design to minimise risks of splashing or spillage, and the promotion of 'closed circuit' handling systems, eg chemical probes.

Barriers

- General unwillingness to implement government intervention in an area without a clear cut need and well documented information on the direct and indirect effects of such intervention.

On-farm Clean Up of Chemical Contamination

The overall issue:

Contamination of land, water or agricultural produce on farms may occur in three ways: directly by spillage or leakages of chemical products, indirectly as a result of extreme levels of applied/administered products (which may result in a residue problem) or accidentally by chemical trespass or administration of incorrect products.

Large scale contamination arising from leakages or spillage is the responsibility of the State Disaster Organisation which has procedures to deal with such incidents. Smaller spills in farmers' sheds represent a different situation but can have similar health impacts. The use of safety equipment and clothing is becoming more widespread. However, bystanders may be at risk, particularly when chemical products are decanted in preparation for their use and spills occur. Both the clean-up process and the subsequent disposal of contaminated material may expose toxic substances for prolonged time spans and there is a need to educate users better in clean-up procedures.

Opportunities:

- Education programs on spillage prevention and on the health and environmental benefits of proper clean-ups.
- Development and promotion of safer packaging to reduce the risk of spillage.
- Chemical absorbents provided by chemical industry as a promotional give-away.
- Financial incentives for farmers to have clean-up facilities available.

Barriers to achievement:

- Lack of facilities (including a high temperature furnace) to dispose of contaminated material off the farm.
- Difficulties in identifying the sources of contamination in some circumstances.

- Cost can be a significant barrier to thorough clean up in some situations.

Chemical Disaster Management

The overall issue:

Chemical spillage and leakages are a common component in many counter disaster plans, particularly in areas where chemicals are manufactured and in the vicinity of many chemical storages throughout the State. Current legislation aims to ensure that the appropriate signposting and safety equipment are in place at such locations.

In the response and recovery phase of a disaster involving chemicals the Department of Labour and the Health Commission would be the first line of contact to obtain advice or help while the Department of Agriculture has an advisory role in the State Disaster Plan. This situation may be unfortunate where agricultural chemicals are involved (e.g. pesticides, veterinary drugs, fertilisers or stock feed) since the Department may have more information on particular products than any other agency.

The Department is also the responsible agency for dealing with affected plants, soil or animals where the subsequent fate of affected land, plants or animals must be considered to avoid residues arising in agricultural produce.

Opportunities:

- While chemical disasters will never be totally prevented, a State plan exists to deal with a variety of situations. There is an opportunity for the Department of Agriculture to take a stronger role by ensuring that essential information on agricultural and veterinary chemicals is readily available to disaster combat authorities, preferably via computer database.

- In addition, clear guidelines should be developed on how to deal with chemical affected crops, soil or livestock as a result of chemical spills.

Barriers to achievement:

- Resources to develop guidelines and databases.

ALTERNATIVES TO CHEMICALS

General

The overall issue:

Concern over the use of synthetic chemicals in pest control, as well as in many other areas, has brought increased pressure to find methods which reduce the use of synthetic chemicals. Much of the research into alternatives was conducted prior to the development of synthetic pesticides and, until recent years, the ready availability of cheap and effective chemicals has limited research into alternative methods. Where alternatives or methods which reduce chemical use are available they are not always used to optimum effect. Research to find alternatives or develop more efficient use of existing chemicals can be a fertile area in the future.

Opportunities:

- The development and increased use of integrated and non-chemical methods of pest control.

Barriers to achievement:

- The development of alternative methods of pest control usually requires a detailed knowledge of the biology, ecology and population dynamics of each particular pest species. Funding for research to provide this knowledge is a significant barrier.
- Measures which increase the use of non-chemical methods must compete with well funded advertising campaigns by chemical companies.
- The development of non-chemical methods of pest control require long-term research projects which do not compete favourably for funds when 'quick fix' chemicals are available.

Specific alternatives to chemical control are discussed in the remainder of this section.

Physical and Cultural Means

The overall issue:

These methods aim to alter the environment in favour of the host and to the detriment of the pest. They were the chief means of pest control before the advent of chemical pesticides and are often long lasting or permanent in their effect. However, in many cases the ready availability of synthetic chemicals has meant that their effectiveness has become under-valued and they are often not used to their full potential. Very often education is an important part of achieving most effective use of these methods. Examples of physical or cultural means of pest control include: cleanliness and rubbish removal in urban cockroach and rat control programs, and the destruction of rabbit warrens. Development of new

physical and cultural methods of pest and disease control requires detailed knowledge of the specific biology and ecology of each pest species.

Opportunities:

- Promoting greater use of these methods within integrated disease/pest control programs.

Barriers to achievement:

- The availability of chemicals as a 'quick fix'.

Biological Control

The overall issue:

Biological control is the use of natural enemies to control pests. Biological control measures may not eradicate pests and diseases, but can be used to prevent the rapid spread of the pest or to create a balance between populations of pests/disease organisms and their enemies which will prevent economically significant damage to agricultural crops and animals.

Three broad categories can be distinguished.

1. Classical or inoculative biocontrol - an introduced biological agent is expected to persist in the ecosystem suppressing populations of, or damage by, the target pest. This is the category that most people think of when biocontrol is discussed.

2. Inundative biological control - large numbers of an organism are applied as a type of 'biological pesticide'. Generally the biocontrol agent does not persist in sufficient numbers to give on-going control.

3. Conservation or enhancement of natural parasites and predators - usually achieved by environmental manipulation or choice of favourable control programs.

The development of inoculative biocontrol programs requires detailed research to clarify the biology of the target pest, identify possible predators or parasites in other environments, satisfy quarantine requirements and develop rearing and release methods. The development of inundative control programs also requires research to identify and test potential species and to develop rearing and application techniques. However, unlike inoculative biocontrols the costs of developing inundative controls can be recovered through the sale of the biocontrol agents.

Opportunities:

- Increased use of biocontrol programs for pest control. Particularly fruitful areas are:

- Weed control by introduced natural enemies has often been effective in the past and should be as effective in the future.
- Vertebrate pest control by pathogens
- Microbial control of livestock pests
- Biological control of medical pests, in particular mosquitoes

- Breeding of insecticide resistant parasites and predators for use in integrated control programs.

Barriers to achievement:

- Funding for research into possible biological control strategies, and funding for biocontrol release programs, has difficulties because all producers in an area benefit but not all will be prepared to pay. Thus, legislative support to collect a levy (not always acceptable), direct government funding, or support by an industry body(s) will be required.

Autocidal and Genetic Control

The overall issue:

Autocidal control is the employment of an organism, or some characteristic of an organism, to destroy or reduce the reproductive potential of the same species. When this is achieved through manipulation of the genetic composition of the pest population it is known as genetic control. One of the outstanding advantages of genetic control is its specificity. There are no effects on other species and no environmental contamination.

Genetic control usually falls into one of two categories :

1. Suppression of pest populations through the introduction of high levels of structurally abnormal chromosomes which result in death of offspring or have a deleterious effect on reproduction.

2. Manipulation of the gene pool of the pest population in a way which brings about reduction in the population or renders the pest susceptible to other control measures.

For effective genetic control, each program must be tailored to suit the unique features of the specific target pest population. This requires research to provide precise knowledge of the physiological, biochemical and behaviouristic genetics of the specific population to be targeted, as well as detailed knowledge of the population dynamics and ecology of the pest species.

Opportunities:

- Potential use against all pest species. Genetic engineering technology will enormously increase the availability and applicability of this method of control.

- Control of fruit fly by sterile male release as a cheap alternative to pesticides.

Barriers to achievement:

- The necessary background research, and the development and conduct of rearing and release strategies, must be funded from some source. It is unlikely that chemical companies or farmers would be willing to bear the full cost, since the benefits would accrue to everyone in a particular area whither or not they have paid for the benefit.

Genetic Improvement in Host Resistance

The overall issue:

Genetic resistance to parasites and disease amongst varieties of plants and animals and amongst individuals within varieties can often be used to reduce or eliminate the need for chemicals in pest/disease control programs. Sometimes breeders of new varieties also distinguished **tolerant** strains which are plant/animal strains which have little or no effect in preventing the build up in pest numbers but which can withstand relatively high levels of parasites with little effect on yield.

In any breeding program, disease/pest resistance is only one of the attributes that the breeder is seeking to develop. Many other attributes will also be sought after, the most important usually being yield or productivity. In addition, for host resistance or tolerance to give significant reductions in pesticide usage, producers must recognise economic thresholds for insecticide applications and adjust their application strategies accordingly.

Breeding for resistance is a slow process in animals because of the long generation time involved and because it is not presently possible to use many of the techniques available to plant breeders (eg cloning, selfing, genetic engineering and vegetative techniques). Because of these limitations, increasing the emphasis on disease resistance reduces that which can be given to other characteristics of economic importance and may render breeding for resistance untenable.

The introduction of Plant Variety Rights (PVR) has enabled the monetary value of new plant breeds to be captured and should encourage private sector plant breeding, especially in the ornamental and horticultural sectors.

Opportunities:

- Continued breeding of new varieties of plants and animals which are resistance to significant pests and diseases.

- The use of genetic engineering techniques to increase the genetic improvements possible in host resistance. Examples of this are already being seen with the use of

these methods to transfer resistance genes between species and even classes of organism (for example, the transfer of genes from Bacillus thuringiensis bacteria to the genome of tomato plants to confer resistance to insect attack and the transfer of herbicide resistance genes to crop plants).

- Research into the immuno-genetics of disease and parasite resistance in animals may give new potential for increasing resistance in livestock.

- Development of artificial breeding and cloning techniques to increase the rate at which genetic improvements in resistance can be incorporated into superior animal strains.

Barriers to achievement:

- Presently there are no registration protocols for organisms produced using genetic engineering techniques making research unattractive to the private sector.

Vaccination

The overall issue:

Vaccination is a proven method of protecting animals against a range of diseases caused by bacteria and viruses and is presently being researched as a method for controlling internal and external parasites of animals. Vaccines are used to prevent disease and thereby remove the need for later treatment, especially by antibiotics. MRLs are not required for vaccines and they are not scheduled poisons. Nevertheless, some vaccines may contain live bacteria or viruses and must be handled with care. Almost all vaccines are now being developed by genetic manipulation.

Opportunities:

- Further development of vaccines for controlling animal diseases and internal and external parasites.

Barriers to achievement:

- Lack of basic understanding of the immune reactions between host animals and infectious micro-organisms, internal and external parasites.

- Lack of suitable adjuvants for the delivery of vaccines to food animals.

Eradication, Quarantine and Legislative Control

The overall issue:

The most effective way of avoiding damage by a pest is to prevent its introduction in the first place. Quarantine procedures are vital to prevent the inadvertent or deliberate

introduction of exotic species into Australia and thereby help to contain costs of production, reduce pesticide use and maintain overseas markets for Australian produce.

A number of instances of successful eradication of pests from Australia can be cited but eradication will only be practicable in special circumstances. The development of both effective quarantine and eradication procedures requires a detailed knowledge of the habits and biology of the target pest.

Opportunities:

- To maintain South Australia's 'free' status for many pests and disease through effective quarantine and eradication services.

Barriers to achievement:

- Effective quarantine and eradication programs generally require supporting legislation. Enforcement of legislation to control pests, for example noxious weed legislation and the Stock Diseases Act, has historically been Government funded and thus involves cross subsidisation of the beneficiaries of the act by other sections of the community.

- The emphasis of quarantine and legislative measures are generally given to obvious pests because of community or industry pressure. Those pests with the most potential for eradication or control are often neglected.

Changing Consumer Perceptions

The overall issue:

Education and extension measures to reduce pesticide use fall into two main categories :

1. Education of chemical users about alternative methods, integrated programs and the most efficient use of chemicals when chemical application is required.

2. Education of consumers or people affected by pests. Often pesticides are applied for cosmetic reasons alone. Sometimes low levels of pests or diseases can have dramatic effects in reducing price or rendering produce unacceptable for market, even though the quality and taste is not affected. Intensive pesticide applications are used to achieve a completely parasite and blemish free product. Regular pesticide applications are conducted in some areas of human habitation to prevent the possible occurrence of any insects and appease an unreasoned 'entomophobia'.

Opportunities:

- Training programs for pesticide resellers and applicators on the most efficient use of chemicals. (This is increasingly being addressed in specialised courses and as part of most general agricultural training courses.)

- Changing consumer perceptions to allow acceptance of a certain amount of cosmetic damage or to accept the presence of an occasional insect.

Barriers to achievement:

- Marketing campaigns which reinforce the need for blemish free produce and the need for a completely pest free environment.

Non-pesticide Chemicals

The overall issue:

These are chemicals which are not acutely toxic to the pest, but which reduce its pest status by other means. Five categories of non-pesticide chemicals can be distinguished:

a. Attractants - May be used in traps to directly reduce pest numbers, to time the application of other control strategies, to attract a pest to a source of disease or parasite, to facilitate the spread of a biocontrol agent through the pest population, or to a source of chemosterilant.

b. Repellents - A number of categories including vapour repellents, locomotor stimulants, antifeedants and oviposition deterrents can be distinguished. They have particular advantages against pests such as biting flies and disease vectors as a pesticide may not kill these pests until after they have already bitten or transmitted a disease.

c. Semiochemicals (behavioural chemicals), which include pheromones, tend to be very specific and active in very small concentrations. Pheromones have been used in two main ways: as attractants in traps and for disruption of mating. The development of controlled release systems which can release the desired concentration of pheromone over extended periods of time has greatly facilitated the use of pheromones and other semiochemicals in pest control programs.

d. Growth regulators - Such as synthetic hormones, act to interfere with growth processes of pests. They tend to be specific in effect, generally have low mammalian toxicity and have few unwanted effects on non-target organisms or the environment.

e. Chemosterilants sterilise at the applied dose rather than kill. In addition to being unable to successfully breed the sterilised pests compete with fertile ones for mates.

Opportunities:

- More extensive use of these chemicals as alternatives to pesticides or to increase the efficiency of pesticide applications.

Barriers to achievement:

- The availability of suitable compounds.
- The development of programs to utilise them efficiently.

EDUCATION AND INFORMATION

Technical knowledge needed to manage farm enterprises effectively

The overall issue:

The knowledge and technology involved in modern, profitable farming is becoming more sophisticated and complex. This means that on-farm decision making is also becoming more complex as farmers are required to take increasing amounts of information into account. In addition, the successful application of many new techniques and technologies often assumes a certain level of knowledge in a wide range of subjects from general biology to economics to the use of computers. This has implications for achieving a more judicious use of chemicals in agricultural production.

Alternatives to chemicals, and methods of reducing dependence on chemicals, often rely on an understanding of biological and ecological principles for their application. As more narrow spectrum chemicals become available, there is a greater need to be able to correctly diagnose the pest problem and to select the optimum solution based on the severity of the problem, costs of alternatives, and local conditions.

Knowledge of chemical products available, their correct concentration, application and timing is important to extension officers whose advice on such matters is sought by primary producers. Further, a knowledge of residual effects, withholding periods, and possible side effects is necessary to provide competent advice. There is a vast number of different chemicals and brand names involved, and it is becoming increasingly difficult for individual advisers to remain technically up-to-date on all aspects of agricultural and veterinary chemicals.

Opportunities:

- Provision of monitoring services and control advice (appropriate chemicals, alternatives to chemicals, efficient control).

- Develop a computerised system to augment current chemical charts and to develop an "expert system" for use by staff from whom advice on agricultural and veterinary chemicals is sought.

Barriers to achievement:

Availability of information

The overall issue:

Only part of the total information known about a chemical is available to the chemical user. Chemical companies, regulatory authorities and research organisations often possess more information which could usefully be made available to users and which would also be of use to interested non-users. Material safety data sheets, results of trial work and

information on toxicity are examples of such information. Farmers and other chemical users are being asked to be more discriminating in their choice and use of chemical products. Access to more information than is given on chemical labels assists decision making and is a valuable adjunct to training/education programs.

At the moment information to end-users is provided mainly by Departmental fact sheets, spray charts, product labels and chemical industry promotional material which may not necessarily be in complete accord with the registered status of the chemical. Information on registered uses is at best incomplete and often out-of-date. The introduction of greater legislative control of chemical use may create an obligation to provide timely advice on what uses are allowed as well as which ones are banned and why.

Current computing technology can provide end-users with up-to-date information on chemicals and technical background information. Graphic images (labels or pictograms) can also be used and do not require comprehensive computing skills, or even reading skills.

The Department of Agriculture will be looking increasingly to charge for services over the next decade or so. Previously, a policy of group extension has been in vogue. In a more commercial environment clients will want expert, one-to-one advice if they are required to pay. Individual extension officers will need to be supported by agricultural and veterinary chemical specialists in such an environment to ensure the correct advice is provided in what is a more complex management environment. There is a trend toward increased litigation for incorrect technical advice associated with recommendations made on the use of agricultural and veterinary chemicals.

Opportunities:

- Summarise or edit information from sources such as material safety data sheets into a form which is readily understandable by non-technical people and readily applicable to on-farm decision making.

- Development of user-friendly data bases and computing systems for agricultural advisers and/or chemical users.

- The development of consultancy services based on integrated pest management principles for agricultural industries in South Australia.

- Create full-time agricultural and veterinary chemical specialists to support extension officers in a commercial environment.

Barriers to achievement:

- Resources for summarising, editing and interpreting chemical information and for developing appropriate computer systems.

- It is not presently well known how or from whom farmers are getting their pest management advice. The best method of providing pest management information is therefore not certain.

Public training and education

The overall issue:

General education and training of both farmers and the general public regarding farm chemicals is required in a number of specific areas. The primary objective is to provide farmers and the general community with the background knowledge and understanding needed to make their own decisions about proper and judicious use of chemicals. This can be achieved by ensuring that both the rural and urban communities are given basic information about types of chemicals and their safe use, the risks and benefits of chemicals and the regulatory system that exists to protect users, public health and the environment.

There is a growing preference in the community for healthy, natural and/or 'environmentally friendly' products and lifestyles, and public perceptions of farm chemicals are generally negative. Chemicals are seen as potential or actual contributors to environmental damage and their use in agricultural production is sometimes portrayed as quick, convenient solutions which sacrifice longer term sustainability for short term economic gain. Synthetic chemicals are perceived as inferior to 'natural chemicals' and 'natural alternatives'. In reality, the chemicals used in agriculture are a relatively small contributor to the total pollution and environmental damage problems of modern societies. In addition, chemical residues in Australian agricultural produce are not a hazard to consumers (ASTEC Report, 1989).

Opportunities:

- Engender greater understanding of the role of chemicals in farming practices and their methods of use.
- Provision of information/education to improve understanding of the benefits and risks of chemical use to enable urban and rural communities to make rational decisions on the appropriate level of chemical use.
- Public education to ensure that people understand, or have access to information on, the structure and work of the regulatory system.
- Greater accessibility of the regulatory system to the public via education programs, consultative groups, and the right to lodge complaints.

Barriers to achievement:

- The public has little knowledge of government regulation and often lack faith in the ability and willingness of government advisers to provide them with information and to protect the environment and public health.
- Public scrutiny and debate on chemicals will continue to be influential in shaping public policy. Opinions which are not based on scientific data or are argued unreasonably are barriers to retaining rational chemical usage.

LEGISLATIVE AND POLICY ASPECTS

Clearance and registration of biological pesticides and recombinant DNA organisms or products

The overall issue:

Advances in genetic engineering and biotechnology will result in agricultural and veterinary products based on genetically manipulated organisms (GMOs) and other biologically derived substances. These products, GMOs in particular, will require more specialised environmental assessment prior to their acceptance for use. Whilst the Genetic Manipulation Advisory Committee (GMAC) is already consulted as part of the clearance process, it is recognised that there is no legislative authority (either in S.A. or nationally) for the work of GMAC or for the release of genetically engineered products.

Opportunities:

- Working parties have already been established in S.A. and nationally to investigate the need for legislation and an appropriate procedure for assessing GMOs for release. Agricultural and veterinary chemical regulators should maintain contact with these groups and be ready to assess and implement their recommendations.

Conflict of interests

The overall issue:

Conflicts can arise between the interests of community groups and/or government authorities over the use and regulation of agricultural and veterinary chemicals in such areas as public health, water quality, pollution, waste disposal and spray drift.

Departments of Agriculture have relatively low profiles and generally less public importance than health and, in some cases, environmental authorities.

Opportunities:

- There is a need for agriculture to recognise and respond to the concerns of community groups and be aware of the responsibilities of non-agricultural authorities.

- Similarly there is a need to ensure that non-agricultural groups and authorities understand the role of chemicals in agricultural production, and that agricultural industries and Departments of Agriculture play their full part in the resolution of these issues.

Barriers to achievement:

- Agricultural industries and authorities may be perceived as self interested or biased

with respect to chemical matters.

Improvements in regulation

The overall issue:

The State/Commonwealth agricultural and veterinary chemicals regulatory system is under increasing pressure to eliminate duplication, inconsistencies and delays. The network of governments, committees and authorities involved in regulating chemicals is bewildering to outside observers. Although Australia's regulatory system is effective, it is not always efficient, and the credibility of the system and its administrators suffers.

The Special Premiers' Conference held in October 1990 declared an intention to eliminate duplication and inconsistencies between tiers of government and individual States and specifically instigated a review of chemical registration.

Opportunities:

- By adopting uniform regulations and participating in national schemes, significant opportunities will arise to reduce the cost of regulation and better adapt to changing trade and technology. The registration of chemicals is an area where a national scheme will result in such benefits.

Barriers to achievement:

- Cost of establishing national regulatory apparatus.

- Danger of over-centralisation of regulatory controls and absence of regional inputs in the chemical registration process.

Small size of Australian chemical markets

The overall issue:

The Australian agricultural and veterinary chemicals market is small compared to the world market. Sales of agricultural chemicals in Australia were around A$585 million in 1989 compared to world sales of A$28,000 million. Sales of veterinary chemicals were around A$283 million in Australia and A$13,000 million world-wide in the same year. The Australian farm chemicals industry is dominated by large multinational companies and in 1987 some 19 companies accounted for 90% of the sales turnover of basic chemical manufacturers and formulators. The Australian industry is predominantly a formulating industry based on imported technical grade active constituents (TGACs). Few TGACs are manufactured in Australia.

Registration and clearance requirements involve considerable costs for chemical

companies. Preparation of information to support clearance and registration, explicit up-front and on-going fees, and the need to satisfy the registration requirements of up to 6 States and 2 Territories make the cost of registration and clearance considerable. It is not economic to undertake clearance and registration if sales of a chemical are not sufficiently assured to return a reasonable profit on research, development and regulation costs.

Although many of these costs can be considered as 'costs of doing business', the consequence is that some useful chemicals or minor uses of other chemicals will not be registered. In addition, with relatively small chemical sales in Australia, and with low profit margins on many products, there is often little scope or incentive for developing solutions to local problems. A company's decision on whether clearance and registration of chemicals will be undertaken is an economic or financial decision, and not necessarily based on the actual needs of farmers.

For some time chemical companies have been pressing for an extension to the patent term for chemical products, and for proprietary rights to data on pesticides. The chemical industry believes these steps would help to provide sufficient economic gains for companies to undertake clearance and registration, or to collect required data on off-patent and otherwise low profit-margin products.

Opportunities:

- A system of national registration will be more streamlined than existing State by State registration.
- Increase private research and development of chemicals in Australia by policy and legislative changes which make the development and registration of chemicals for Australian users more attractive to chemical companies.
- Contract research on fee-for-service basis.

Barriers to achievement:

- Lack of economic incentive for companies to develop, clear and register products for minor or special uses.

Provision of policy advice to Governments

The overall issue

The Department of Agriculture is represented on a large number of committees and working parties which provide recommendations on policy matters to State and Federal Governments.

Among the more important National committees rank the Australian Agricultural and Veterinary Chemicals Council (AAVCC) under which clearances are dealt with by two technical bodies, the Agricultural Chemicals Advisory Committee (ACAC) and the Veterinary Chemicals Advisory Committee (VCAC) respectively. Under the umbrella of

the Standing Committee on Agriculture (SCA), the Co-ordinating Committee on Agricultural Chemicals (CCAC) deals with a range of issues and the Animal Health Committee (AHC) deals with residues in meat. Within SA the Ministers Advisory Committee on Agricultural Chemicals (MACAC) provides advice to the Minister of Agriculture, and the Department is represented on the Drugs Advisory Committee, the Co-ordinating Committee on Hazardous Chemicals and the Environmental Protection Council to ensure that agricultural interests are cared for within the portfolios of health, labour and environment.

The multitude of committees and associated working parties result in considerable time spent on servicing these bodies, briefing and debriefing departmental representatives, report writing and feedback to other units who need to know. This may result in a considerable cost to the Department and may constitute a risk of an inconsistent Departmental position given the large number of people involved. Agricultural and veterinary chemical issues are often of a complex nature requiring substantial technical and policy inputs and it is often difficult to ensure that all parties are kept well informed of the latest development within a given issue.

There is a need to critically examine involvement of Departmental staff in chemical related committees at both a State and Federal level. The cost of providing advice and other services to those committees (including salaries) should be clearly identified. Provision should be made within budgets for participation in committees with a high priority for the Minister and Department. Low priority committees should be supported only when resources are available.

Opportunities:

- Taking advantage of available computer technology to handle enquires and dissemination of committee briefings and reports

- Identify costs of providing advice and other services to committees and introduce budgets (salaries and operating) for the work of internal working parties

Barriers to achievement

MARKETING OF PRODUCE

Trade requirements

The overall issue:

Trade requirements are a major determinant of issues and priorities relating to the use of agricultural and veterinary chemicals. Australian agricultural producers must meet whatever standards are set for commodities if export markets are to be satisfied. The regulation of chemicals and standards for produce must also be sensitive to trade pressures. In many instances government regulation is introduced in response to trade standards as a means of ensuring Australian producers meet all requirements so that export markets are not at risk.

Agricultural trade matters are largely outside the control of State Departments of Agriculture (i.e. chemical regulators), and in many cases agricultural trade requirements are outside the influence of the Australian government. Requirements for nil residues of particular chemicals may be instituted as non-tariff trade barriers, rather than because of scientific evidence of adverse health or other effects.

Opportunities:

- Monitor overseas requirements to ensure that Australian agriculture is well informed on trade standards for chemicals and other potential contaminants such as heavy metals.

Barriers to achievement:

- Import standards of foreign countries may not be well-known or may not be clearly stated.

Market potential for low/nil residue and organic produce

The overall issue

Consumers are increasingly demanding residue-free produce and this has lead to a world-wide boom for organic farming industries, as well as for manufacturers who can capture a local market niche where produce is free of certain chemicals (e.g. the Insecticide Free Fruit Company).

This demand is fuelled by publicity which often depicts chemical use patterns from overseas. However Australian agriculture is characterised by low input systems compared to farming systems employed in Europe or the United States. Even our intensive industries are often not as intensive chemical users as those overseas.

Consequently, Australian agriculture has an international marketing advantage by virtue of

our already low chemical usage; this potential is enlarged where Australia can demonstrate effective regulatory controls to safeguard residue standards. This is demonstrated in the case of hormonal growth promotants where we can satisfy European trade partners that no meat from treated cattle will reach that market.

While integrated pest management systems bring together the best in chemical, and non-chemical controls, it is recognised that a small but significant market exist for organic produce. Organic farming systems have a good potential to develop specific market niches where consumers are prepared to pay a premium for the intrinsic quality of the product or for a life-style or sustainability concept.

Opportunities:

- Market opportunities for Australia's low chemical input produce should be explored at home and internationally.
- Provision of technical advice on organic farming systems
- Departmental programs which promote lower use of chemicals
- Emphasise the differences in agricultural systems between Australia and overseas.

Barriers to achievement:

- Improved analytical capability improves the detection limits of residues, thereby fuelling public concerns over perceived increased levels.

Consumer perceptions

The overall issue:

At the AVCA convention in Adelaide, October 1990, Rosemary Stanton, a leading nutritionist, said that many people are more concerned about chemical residues in their food than about other aspects of their diet, such as fibre and fat consumption. In fact, some people use possible chemical residues as an excuse for not adjusting their diet to include fresh fruit and vegetables.

While the fear of being poisoned by residues is understandable, it should be recognised that consumer perception is often directed by the media and skilful advertising. Within the last year there has been a considerable increase in advertisements boasting environmental friendliness and concerns for the consumer's well-being, for example phosphate-free dish washing detergent, rice without cholesterol, insecticide-free oranges.

Unfortunately, the good residue status of Australian produce is hard to convey to consumers, partly because it is not as newsworthy as alleged residue 'scandals'. The Department of Agriculture could take a more proactive role in the food safety debate and form closer links with the food manufacturing industry. This would provide a good

feedback mechanism to agriculture in adjusting to consumer demands while protecting the livelihood of agricultural industries and their dependence on chemicals. Various food safety promotion programs have been established in other States and overseas (e.g. Clean Agriculture in Victoria, the US FoodWatch program). These have a basic recognition of consumers right of choice while at the same time providing educational training in food safety issues, establishing the feedback mechanisms at the producer level to implement change and putting the chemical debate in perspective.

Opportunities:

- Improve consumer confidence in food safety to reduce the perceived problems due to chemical residues.

- The Department already conducts an extensive range of programs aimed at improving food quality, including a policy of minimising chemical use. These programs are not readily recognised by consumers but could easily be used in food safety promotional campaign.

Barriers to achievement:

- Current public perception.

- Good news on current Australian food may not captivate the media to the same extend as (perceived) bad news.

STRATEGIC PLAN

POLICY FRAMEWORK

The following general statements summarise the overall policy conclusions of this report:

- While agricultural and veterinary chemicals have a key role in most farming systems, the Department should promote development of integrated pest control and production systems which lower agriculture's reliance on chemical products;

- Agricultural industries will be best served by the continued development of integrated production systems which bring together the best in genetic improvement of plant and animals, biologically based control of pests and diseases and the judicious use of chemical products, while conserving the resources of soil and water upon which agriculture depends;

- Chemical issues should be managed by a proactive, educational approach with regulation as a supportive measure where appropriate; and

- The public has a right to be informed, to avoid chemical exposure and have a choice of food produced from a range of farming systems including those without use of chemicals.

PRIORITY RANKING OF ISSUES

The commodity group attempted to rank the seven programs and individual issues detailed in the Issues, Opportunities and Barriers section of the report. Many issues were seen as important from a longer term perspective although they were not causing problems at the moment. Other issues were assessed as having immediate priority because of their sensitive nature rather than because of longer term benefit to agriculture. Ranking by the commodity group proved to be very difficult but some general trends were apparent and are offered as a basis for further discussion.

The seven major program headings were ranked as follows

Most important	Efficiency of chemical use
	Human safety
	Off-target effects
Medium importance	Alternatives to chemicals
	Education and information
	Marketing of produce
Less important	Legislative and policy aspects

Within the efficiency of chemical use program the most important components were integrated pest management, resistance to chemicals and economic thresholds.

Residues in food and misuse of chemicals were the most important aspects of human safety.

In relation to the program on off-target effects, the issue of chemical purity was seen as less important than the other issues.

The ranking of alternatives to chemicals indicated that biological control was perhaps the most important issue but this was not a clear trend.

There were no definite trends within the remaining programs.

INVESTMENT OF DEPARTMENTAL RESOURCES

Agricultural and veterinary chemicals are an integral part of most Departmental programs in line with plant and animal breeding and husbandry Many Departmental projects can be attributed to chemicals, chemical use or developing alternatives to chemicals in one way or another. Nearly every extension, research and regulatory officer deals with chemicals, yet only few projects and units have chemicals as the primary component of their work.

Some of the major areas of the Department which have a strong "agricultural and veterinary chemical element" are:

Farm Chemicals Branch
Pesticide and the Food & General Chemistry Laboratories of SCL
Animal and Plant Control Commission
Pest Eradication Unit
Plant Protection Officers
Weeds Research Unit

The Entomology unit, Horticultural Branch, the Soil & Water Conservation Branch, the Plant Nutrition Unit, Animal Industry Branch and the Animal Health Branch also have major chemical-related programs. Staff with agriculture, horticulture or livestock functions located in regional research and extension centres spend a significant part of their time on chemical related research, extension or regulation.

The commodity group could identify over 260 current trust funded projects containing activities related to agricultural and veterinary chemicals. It was impossible to clarify the extent of these activities and any extrapolation beyond these dimensions is not likely to provide more relevant information of Departmental investment at this stage. Nevertheless, the difficulty in analysing this information demonstrated how integral agricultural and veterinary chemicals are to Departmental activities.

The Department established a working party some time ago to examine matters related to food quality, chemical residues and the developing concepts of organic farming. One of the terms of reference of the working party was to identify current Departmental activities related to contaminants in food. This working party had the same experience as the commodity group in trying to identify programs and projects on chemicals, but was able to develop a list of activities based on Departmental unit plans developed early in the

commodity planning process. This list is attached to this report as Appendix G. While the list has a bias towards food and residue related activities and excludes activities within soil conservation and animal and plant control, it illustrates the diversity of projects and programs within the Department with chemical aspects.

APPENDICES

APPENDIX A Explanation of Pesticide Residue Limits

Maximum Residue Limits (MRLs). A scientific basis exists for establishing the upper limits of residues in food. An MRL is-

> *'The maximum concentration of a residue that is legally permitted in or on a food or food commodity'.*

This should not be exceeded if the chemical is used according to good agricultural practices.
The concentration is measured in milligrams of the residue per kilogram of the food (mg/kg). One mg/kg is equal to one part per million (ppm).

The MRLs are determined by a committee of the National Health and Medical Research Council (NH&MRC) using internationally accepted procedures.

MRLs are based on scientific data produced during product development. This data includes acute, sub-chronic and long-term toxicity studies and investigations of metabolism, reproductive toxicity, development toxicity, mutagenicity, carcinogenicity or other properties.

These studies and experiments are designed to provide evidence of any potential short or long-term hazards from which relative safety can be deduced. Before an MRL is derived other parameters need to be determined. These are:

No Observable Effect Level (NOEL) - is the highest dose-level which produces no observable toxic effect in the most sensitive test species. It is expressed as mg/kg of body weight per day.

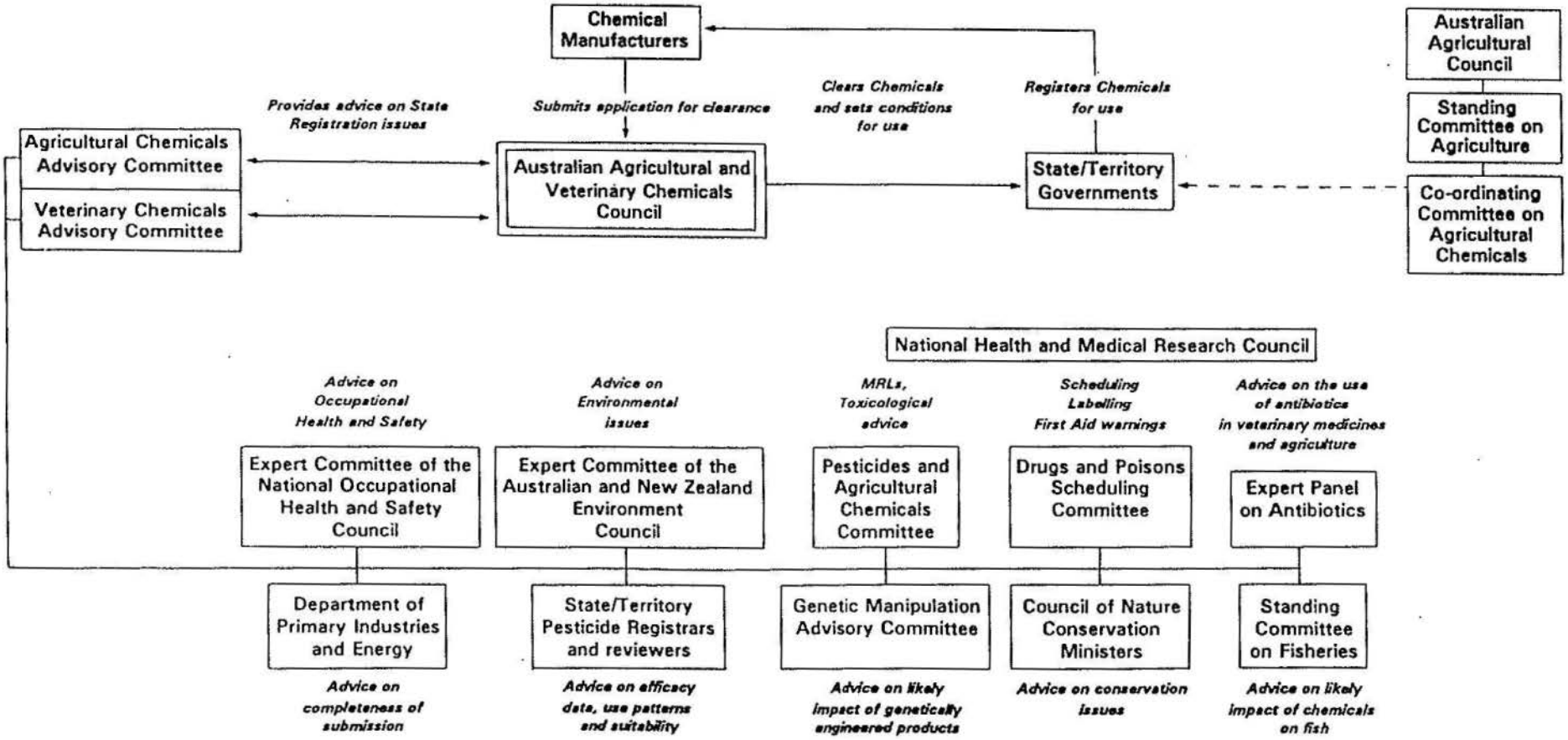
Acceptable Daily Intake (ADI) for Man - is the daily intake which, during an entire lifetime, of exposure at that level, is almost certain not to result in injury on the basis of available evidence. It is also expressed as mg/kg. The ADI is usually calculated as one-hundredth of the NOEL.

The MRL is calculated so that the ADI will not be exceeded by the sum of the residues in the human diet from all possible sources.

Withholding Period - the minimal interval that should elapse between the last application of an end-use product to any crop, pasture, or animal and the harvesting, grazing, cutting or slaughtering thereof or the collection of milk and eggs for human consumption.

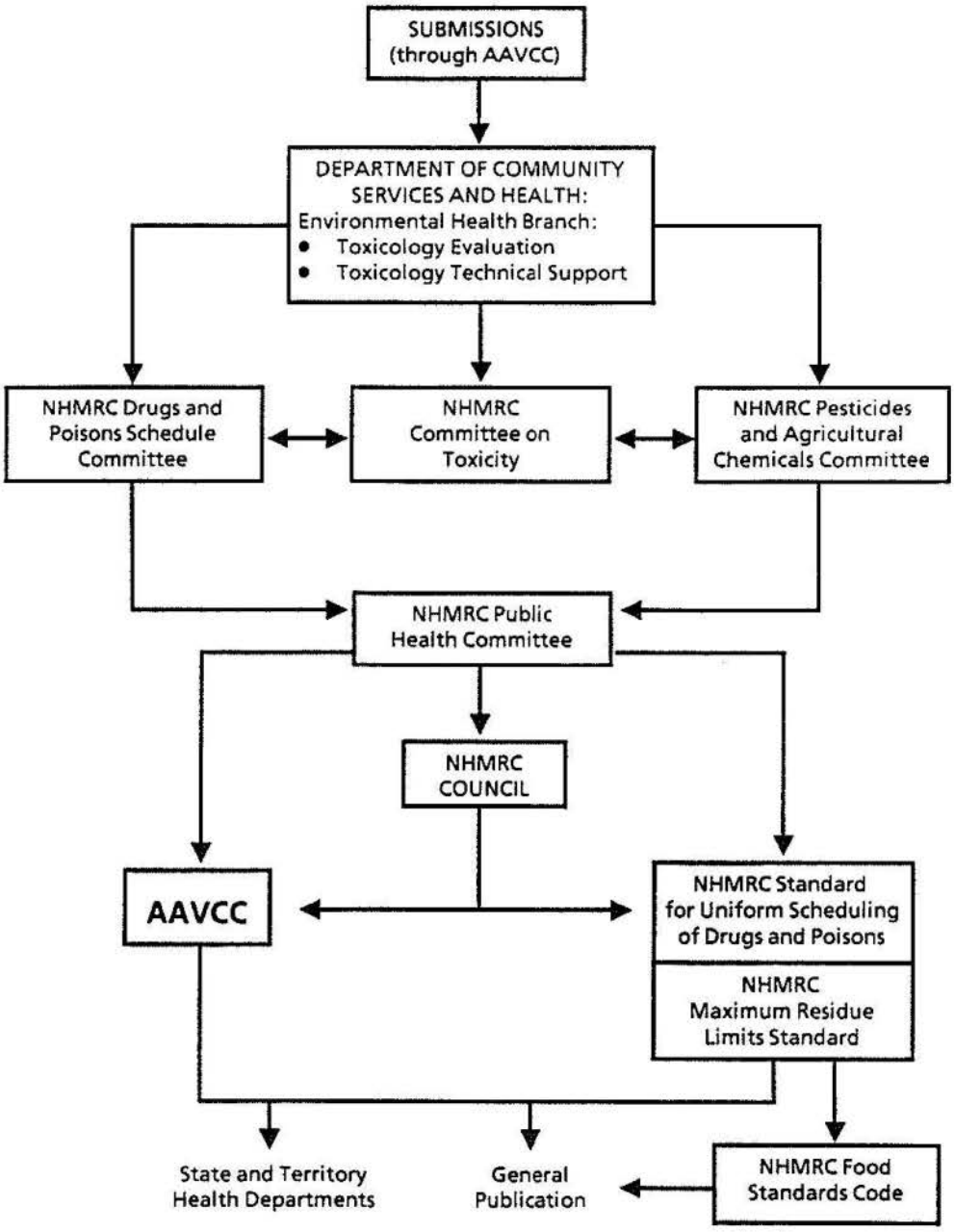
When products are registered, a withholding period is often set for each use situation.
This period is assessed as being the time required for the level of residues to fall below the permitted level (MRL). Observance of the withholding period stated on the label is a legal requirement.

APPENDIX B Clearance and Registration Procedures



Registration and clearance procedures (Source: AAVCC Annual Report 1989-90, p 11)

APPENDIX C Health Assessment for Chemicals
(Source: Senate Committee Report, p 16)



APPENDIX D Fertilisers

The main nutrients are:

1. Nitrogen (N)
   - the major growth nutrient
   - gives green colouration to plants
   - builds plant proteins
   - improves quality of leaf crops

Much nitrogen is lost through leaching and breakdown in soil. It is estimated that half a million tonnes of nitrogen are exported from Australia each year in rural produce and hence must be replaced.

2. Phosphorus (P)
   - stimulates early growth
   - encourages root formation
   - hastens maturity
   - stimulates flower and seed production
   - vital for animal and plant growth

Most Australian soils have little natural phosphorus. Cereals and pastures have a high phosphorus requirement. Large losses of phosphorus occur through fixation, export of products, leaching and erosion. It is estimated that 3kg of phosphate is contained in a steer carcase and 3kg in a tonne of cereal. Around 100,000 tonnes of phosphate is exported from Australia in rural products per year.

3. Potassium (K)
   - essential for formation and translocation of starches, sugars and fats
   - increases quality and plumpness of fruit and seeds
   - aids in protein production

Many coarse textured Australian soils are deficient in potassium. It is required for horticultural crops, and oil seeds. Australia currently has virtually no domestic sources of potassium and imports about 240,000 tonnes of which 150,000 tonnes are re-exported in rural products.

4. Sulphur
   - vital element in wool production
   - promotes nodule formation in legumes
   - essential ingredient of proteins
   - stimulates seed production

Other nutrients include: calcium, magnesium and trace elements such as zinc, copper, boron, cobalt and molybdenum. They all have essential functions in plants and animals.

(Source: Aust. Fert. Industry, p 4)

Australian Fertilizer Manufacturers

STATE	COMPANY (HEAD OFFICE)	PLANT LOCATION	PRODUCT
Qld.	Incitec Ltd	Gibson Island	Ammonia, Urea, Ammonium Phosphates, Ammonium Sulphate
	POSTAL ADDRESS Incitec Ltd., P.O. Box 140, Morningside, Qld., 4170	Pinkenba	Sulphuric Acid, Phosphoric Acid, Alums, Dry Blend Mix Fertilizers and Trace Elements
	Manufacture commenced in 1915.		
NSW	Incitec Ltd	Kooragang Island	Sulphuric Acid, Phosphoric Acid, Ammonia, Ammonium Nitrate, Nitroprill, Ammonium Phosphates, Concentrated Superphosphates
		Cockle Creek	Single Superphosphate
		Port Kembla	Single Superphosphate
Vic.	The Phosphate Co-operative Co. of Australia Limited (Pivot)	Geelong	Sulphuric Acid, Phosphoric Acid, Single Superphosphate, Double Superphosphate, Triple Superphosphate, Dry Blend Mix Fertilizers and Trace Elements
	POSTAL ADDRESS The Phosphate Co-operative Company of Australia Ltd., G.P.O. Box 1322L, Melbourne, Vic., 3001	Portland	Sulphuric Acid, Single Superphosphate, Dry Blend Mix Fertilizers and Trace Elements
		Yarraville	Double Superphosphate, Triple Superphosphate, Dry Blend Mix Fertilizers and Trace Elements
	Owned by 34,500 farmer shareholders. In operation since 1920.		
Tas.	Electrolytic Zinc Company of A'Asia Ltd	Risdon	Single Superphosphate, Sulphuric Acid, Dry Blend Mix Fertilizers and Trace Elements.
	POSTAL ADDRESS Electrolytic Zinc Company of Australasia Ltd., G.P.O. Box 856K Melbourne, Vic., 3001		
S.A.	Top Australia Ltd	Port Adelaide	Sulphuric Acid, Single Superphosphate, Dry Blend Mix Fertilizers and Homogenous Trace Elements and Liquid Fertilizers
	POSTAL ADDRESS **Top Australia Ltd.,** **P.O. Box 334,** **Pt. Adelaide, S.A. 5015**	Wallaroo	Single Superphosphate, Dry Blend Mix Fertilizers and Homogenous Trace Elements
		Port Lincoln	Sulphuric Acid, Single Superphosphate, Dry Blend Mix Fertilizers and Homogenous Trace Elements
	Commenced business in 1881 as a manufacturer of fertilizers.		
W.A.	CSBP & Farmers Ltd	Kwinana	Sulphuric Acid, Phosphoric Acid, Single Superphosphate, Double Superphosphate, Triple Superphosphate, Diammonium Phosphate, Monoammonium Phosphate, AGRAS, Ammonia (Kwinana Nitrogen Ltd), Ammonia Nitrate, Ammonia Sulphate, Dry Blend Mix Fertilizers and Trace Elements
	POSTAL ADDRESS CSBP & Farmers Ltd., G.P.O. Box D148, Perth, W.A., 6001.	Albany	Sulphuric Acid, Single Superphosphate, Dry Blend Mix Fertilizers and Trace Elements
		Esperance	Sulphuric Acid, Single Superphosphate, Dry Blend Mix Fertilizers and Trace Elements
		Bunbury	Sulphuric Acid, Single Superphosphate, Dry Blend Mix Fertilizers and Trace Elements
		Geraldton	Sulphuric Acid, Single Superphosphate, Dry Blend Mix Fertilizers and Trace Elements
	In operation since 1910.		

LEGISLATION AND LEGISLATIVE REVIEWS - SPRAY APPLICATION OF AGRICULTURAL CHEMICALS

ISSUES / APPROACHES	NEW SOUTH WALES	QUEENSLAND	VICTORIA	TASMANIA	SOUTH AUSTRALIA	WESTERN AUSTRALIA
AERIAL APPLICATION	Various provisions of the *Pesticides and Allied Chemicals Act* apply.	See below.	Controlled pursuant to the *Aerial Spraying Control Act*, 1966.	Controlled under the *Pesticides* Act, 1968.	No general statutory controls under *Agricultural Chemicals Act*.	Controlled pursuant to the *Aerial Spraying Control Act*, 1966 and Regulations. Regs. constitute it an offence to 'over spray' in certain conditions.
GROUND APPLICATION	No specific provisions in *Pesticides and Allied Chemicals Act*. Reliance on general provisions (eg. labelling/use) and other pollution control legislation.	Agricultural Chemicals Distribution Control Act controls both aerial and ground distribution (See preamble). Power to issue commercial operators licences (ground distribution) of prescribed classes. See Regulation 9.	No apparent, specific controls over ground application. Presumably, action can be brought under EPA. But no control legislation. Discussion Paper suggests extension of controls to ground spraying (R).	No specific provisions apply to ground application. Licensing of pest control firms extends to ground distribution (see reg. 23A.-23C.).	No specific provisions in *Agricultural Chemicals Act*. Pest Controllers licensed under Controlled Substances (Pesticides) Regulations.	Protection of specific crops within prescribed areas from spraying of esters of acids etc. Under Agriculture and Related Resources Protection Regulations (ARRPR).
GEOGRAPHICAL RESTRICTIONS Environ. sensitive areas Agric. sensitive areas Urban areas	By Ministerial order (S.49A). Prohibition on aerial spraying within 150m of domestic and public premises.	Governor in Council may declare a hazardous area (s.28). Not clearly defined. May issue directions in hazardous area. Green paper suggests replacing with Chemical Control Area. Possible prohibition near human habitation.	Governor has power to declare hazardous area under *Aerial Spraying Control Act* where concentration of susceptible crops (s.7). Discussion Paper suggests broadening to include environment and health factors (R).	Probably under the regulation - making power (s.20). No specific provisions re: "special areas" at present. No powers to exclude spraying near schools, urban areas etc.	No apparent power.	Declaration of hazardous areas under the *Aerial Spraying Control Act*. Specific reference in Regs.
CONTROL OVER SELF-EMPLOYED	No specific provisions. Reliance on general provisions in P&ACA (eg. labelling/use).	Farmer excluded from need to lodge security with standards officer (s.25(b)). Suggested that in threatening situations prohibitions and restrictions would apply to non-commercial users.	No specific provisions. Discussion Paper suggests extension of responsibility to person who hires operator. Also licensing provisions to those who spray "for direct profit".	Does not appear to extend to occupier of land or his/her employee (reg.236(1)).	All existing provisions of the *Agric. Chemical Act* apply (where relevant). Controlled Substances (Pesticides) Regulations.	Restrictions under ARRPR are comprehensive.
ACQUISITION AND DISSEMINATION OF SPRAY DATA	Appears to depend upon labelling requirements of P&ACA (s.15) and Dept. of Agric. & Fisheries.	No specific reference in ACDCA - probably depends on labelling requirements under the *Agricultural Standards Act*.	No specific reference.	No specific reference.	No specific reference.	No specific reference in *Aerial Spraying Control Act* or Regs.
INSURANCE SCHEMES	Approved insurance policy required for issue of aircraft (pesticide applicator) licence (s.22G).	Owner of aircraft/ground equipment must lodge security by way of insurance policy before commencing operations (s.25). Suggested increase in insurance from $30,000 to $100,000.	Owner of aircraft must lodge security by way of insurance before commencing aerial spraying (section 8). Discussion paper suggests increase from $30,000 to $100,000.	No requirement for public liability insurance. Draft Report considers this necessary.	No requirement, currently.	Owners of aircraft must lodge security by way of insurance policy.
NOTIFICATION OF INTENTION TO SPRAY	Regulation-making power - s.73.	No requirement at present. Proposed "reasonable endeavour" notification procedures.	No current requirement. Discussion Paper suggests public notification procedures.	Reliance on Air Navigation Order 3.2 (buildings).	Air Navigation Order 3.2 probably applies.	No current requirement. Probable reliance on Air Navigation Order 3.2.

LEGISLATION AND LEGISLATIVE REVIEWS - SPRAY APPLICATION OF AGRICULTURAL CHEMICALS (Continued)

APPROACHES ISSUES	NEW SOUTH WALES	QUEENSLAND	VICTORIA	TASMANIA	SOUTH AUSTRALIA	WESTERN AUSTRALIA
SUBSEQUENT CIVIL REMEDIES - PRIOR NOTIFICATION OF ALLEGED DAMAGE	Effect of non-compliance with notification requirements - unknown.	Notification required under s.30 Limitation on calling government witnesses in subsequent litigation if no compliance. Court may waive.	Notification required under Section 12. Limitation on subsequent action if no compliance (s.13). Discussion Paper suggests this constraint could be removed.	No apparent requirement for notification or independent loss assessment.	No specific reference.	Notification required under Section 14(4) of *Aerial Spraying Control Act*. Limitation on subsequent action if no compliance.
PROVISION FOR CIVIL CLAIMS	No specific provisions.	No specific provision.	No specific provision, but see above.	No specific provisions.	No specific provisions.	No specific provision.
PROSECUTIONS	Offence to contravene order under Section 49A(1). General offence to cause risk (s.37). Disregard of instructions on labels (s.33). Use of unregistered pesticide (s.31).	Failure to comply with direction given re: hazardous areas (s.29) (4). General penalty provision - s.41.	General powers and penalties, s.16.	Series of offences created by the *Pesticides Act*.	*Controlled Substances Act*, 1984. Significant penalty increases under the *Agricultural Chemicals Act* (Amend. 1987).	General penalty provisions under section 18, *Aerial Spraying Control Act* and Regulation 15. Offence created under Reg. 8 of ARRPA Regs.
SUSPENSION/ CANCELLATION OF LICENCES	Power in Registrar to suspend/ cancel licence (s.22N(1)).	Power in Board to cancel or suspend (s.21). "Show cause" provisions.	Apparent power pursuant to section 6.	Registrar may cancel registration and licence of operator (regs. 23A,23B).	Power of Health Commission to revoke or suspend a Pest Controllers' licence.	Reg. 7 of ARRPA Regs. provides power to cancel or suspend Pilot Chemical Rating Cert.
IMPEDIMENTS TO INSURANCE CLAIMS IF SUCCESSFUL PROSECUTION	No reference.	No reference.	Discussion Paper suggests this should be examined.	No reference.		No specific reference.
APPLICATION OF UNREGISTERED CHEMICALS	Offence under Section 31.	Offence under section 35.	Not covered in this *Act*. Probably an offence under *Agricultural Chemicals Act*.	Offence to sell (s.13). Not, apparently an offence to use.	Unclear that use of unregistered chemical would be an offence under section 11a(2)(a) of the *Agric. Chemicals Act*.	Not determined.
APPLICATION IN CONTRAVENTION OF LABEL	Offence under Section 33.	Offence under section 35.	Not covered under *Act*. Discussion Paper suggests it should be an offence.	Appears not to be an offence.	Offence under section 11(b)(1) of *Agric. Chemicals Act*.	Assumed offence under registration legislation.
CONTROLLING SPRAY APPLICATION OF PARTICULAR PESTICIDES	Possibly by virtue of s.49A(air)	Possibly by virtue of section 28	Possible under the regulation - making power - section 17.	No apparent control.	Minister could control under section 11(b)(1) of *Agric. Chemicals Act*.	Controls pursuant to ARRPR (see above). Aerial Spraying Control Regs. limit application of organochlorines
SPRAYING OVER WATER	Could be controlled by section 49A. No specific reference. Regulation power may be used. *Clean Waters Act*, 1970 and *Environmentally Hazardous Chemicals Act*, 1985 could be applied.	No specific provision. Green Paper recommended that unauthorised spraying over water should be an offence (R).	Could be controlled under extended "hazardous areas" provisions (see Discussion Paper).	General offence to pollute waters through use of pesticide (see reg.20).	See *Water Resources Act* (1990), section 42.	No specific reference. Could be controlled by declaration of hazardous area.

LEGISLATION AND LEGISLATIVE REVIEWS - SPRAY APPLICATION OF AGRICULTURAL CHEMICALS (Continued)

APPROACHES / ISSUES	NEW SOUTH WALES	QUEENSLAND	VICTORIA	TASMANIA	SOUTH AUSTRALIA	WESTERN AUSTRALIA
ENVIRONMENTAL IMPACTS	Probably controlled by Order under s.49A.	Probably (limited) control under section 29.	Not specific at present. Extension of "hazardous areas" provisions would assist. are pollutants. No standards set to govern aerial distribution.	To some degree controlled under the *Environment Protection Act*, 1973. All registered pesticides *Act* - inapplicable.	*Water Resources Act* *Clean Air Act* - could apply to ground spraying. *Agric. Chemical*	Range of environmental legislation would apply.
PUBLIC HEALTH, GENERALLY	Hazardous Pesticides Regulations *(Public Health Act).*	No specific provisions under ACDCA. Noted as defect in Green Paper. Addressed in draft? Application of Agricultural Chemicals Regulations.	*Act* limited.	No specific provisions re: public health. But operators (including Farmers) can be required to take medical examinations (reg.22).	*Controlled Substances Act*, 1984 *Food Act*, 1985.	Health legislation controlling food quality would apply.
OCCUPATIONAL HEALTH	As above, plus occupational health and safety legislation(?)	As above, plus occupational health and safety legislation(?)	Probably under occupational health legislation.		Pesticides (Safe Handling) Regulations, 1979.	—
LOADING, MAINTAINING OR DRAINING OF AIRCRAFT	Hazardous Pesticides Regulations	As above. Probably could be regulated pursuant to section 48 of *Act.*	No apparent controls(?)	Licence conditions - all handling and application to conform with Aerial Agricultural Chemical Rating Manual.	Minimal. Controlled Substances (Pesticides) Regulations.	*Aerial Spraying Control Act* contains power to regulate. No specific regulations.
EQUIPMENT STANDARDS	Regulation - making power under s.73(1). Not apparently used.	Regulation 26 - Board to approve types of equipment. Faulty or defective equipment - controlled by section 36.	Power under the regulation - making provision - section 17.	-	Minimal control. See Pest Control Regulations, reg. 151A(4).	No specific regs.
RECORDING SPRAY ACTIVITIES/ PESTICIDE USE	Record of pesticide application - s.49B. No requirement to record chemical sales.	Records to be kept and produced - sections 26 and 27.	Required pursuant to section 10.	Records to be kept on the amounts of restricted pesticides used (reg.23N). Draft Report describes these requirements as "limited".	No apparent requirements.	Records required pursuant to section 12, *Aerial Spraying* Control Act.
POWERS OF INSPECTION	Powers of inspection, ss.53-55.	Powers of inspection - section 34.	Powers of inspection - section 12.	Provided by section 34, *Pesticides Act.*	*Agric. Chemicals Act.* s.24.	Sections 13A-14 *Aerial Spraying Control Act.*
BINDING THE CROWN	*Pesticides and Allied Chemicals Act* does not purport to bind Crown.	Unless otherwise expressly provided, the *Act* binds the Crown.	Provisions regarding hazardous areas bind the Crown.	Crown does not have to comply.	*Agric. Chemicals Act* does not purport to bind the Crown - not relevant as registration control legislation.	Hazardous areas provisions of *Aerial Spraying Control Act* bind Crown.

(Source: Spray Drift Report, Appendix V)

APPENDIX F Survey of Public Perceptions of Chemicals

(From presentation to the Ministers Advisory Committee on Agricultural Chemicals by Judi Tompkins, Project Officer - Education, Farm Chemical Management and Services Branch)

The majority of South Australians live in urban centres, however primary producers share many of the same concerns about farm chemicals as the urban population. A recent market survey by Frank Small and Associates, in September, 1990 of Australian capital cities (1300 people from Sydney, Melbourne, Adelaide, Brisbane and Perth) has revealed some interesting and disturbing perceptions and attitudes of the members of these urban communities:

* 435 are "extremely concerned" about chemical residues in soil, water and fresh food.
* 65% "Don't know if chemical residues are present in their food".
* 76% agree that "organically grown food is better."
* 57% "would decrease purchases of food if they became concerned with chemical residues."
* 95% agree that "farmers should prove their knowledge of the correct use of chemicals."
* 88% agree that "farmers and their use of chemicals may contaminate water and soil."
* 73% agree that "farmers use too many chemicals."
* 37% agree that "farmers use chemicals carefully."
* 27% are aware that "farm chemical use is regulated by the government."
* 23% are aware that "government watchdogs are always monitoring chemicals in food."
* 32% agree that "removing farm chemicals will have little impact on food quality."

From the same market survey:

* 96% agree that "the government has a responsibility to inform the public about farm chemical issues".
* 14% agree that "the government is currently providing sufficient information about farm chemical issues." (According to AVCA's Public Affairs Strategy: July 1990-June 1993, "The environmental debate in Australia - especially as it relates to the use of farm chemicals - is unduly polarised. The inability or reluctance of regulatory authorities to adopt a proactive role in educating the community about farm chemical issues and responding to the media in relation to those issues has contributed to that polarisation.")
* 47% agree that "media can unfairly create hysteria about farm issues."
* When it comes to believable or credible sources of information for farm chemical information, the results are quite revealing:
  89% agree that "spokespersons from the CSIRO are a believable source for information concerning farm chemicals."
  84% agree that "dietitians or nutritionists...;"
  79% agree that "doctors...;"
  76% agree that "environmentalists...;"

68% agree that "health departments...;"
57% agree that "farmers...;"
55% agree that "farm chemical industry...;"
33% agree that "government...;"
21% agree that "celebrities...;"

This market survey also made the point that there were strong public views that the government should become more involved in telling the public about farm chemicals. the government is seen by the consumers to have a low profile on these issues. However, no matter who the speaker is, or what information is conveyed, there are several approaches which will **not** work in conveying information to consumers:

* the use of technical or scientific words;
* statements that focus on the natural toxins which occur naturally in foods (people feel that the accumulation and association of synthetic chemicals with naturally occurring chemicals will change the chemical structure and be dangerous);
* statements that chemicals in minute amounts are "perfectly harmless" (consumers feel that minute amounts can accumulate into large amounts.)

APPENDIX G Departmental Food Quality and Chemical Programs

(Extract from a report to the Directorate proposing a food safety program)

Departmental Programs Concerning Food Quality, Reduced Usage of Chemicals and Community Concern over Chemicals (Information from Unit Plans)

1. Farm Chemicals Strategic Plan

(1) Administration of State and Commonwealth legislation on registration and residues of farm chemicals.
(2) Education programs concerning farm chemical use and handling.
(3) National and State programs concerning registration, residues, use and disposal of farm chemicals.
(4) Residue monitoring.

2. State Chemistry Laboratories

(1) Screening of food samples and environmental samples for agricultural chemical residues, hazardous chemicals and micro-organisms.
(2) Provide analytical and advisory services.
(3) Development of test methods.
(4) Support for other Departmental and government programs.

DIVISION OF ANIMAL SERVICES

3. Animal Research Branch

(1) Pig health research - Monitoring disease problems of significance to S.A. industry and controlling diseases of major importance.

4. Sheep And Wool Section

(1) Worm check - This program aims to improve the efficiency of worm control and slow down the onset of drench resistance by internal parasites in sheep in S.A.. Effective introduction will result in reduced usage of effective drenches.

5. Dairy Section

(1) Overall program of advising dairy farmers and manufacturers to improve quality control and product quality and offer advice concerning residues of pesticides, antibiotics, iodine etc.

6. Central Veterinary Laboratories Branch (VETLAB)

(1) Conduct research into animal health problems of significance in S.A..
(2) Provide veterinary support services to the Department and industry.
(3) Cadmium survey in livestock.

7. Poultry Section, Animal Industry Branch

(1) Maintain the health and productivity of the State's poultry flock by proper disease control and stock management procedures.

8. Animal Health & Regulatory Branch

(1) To maintain and enhance the hygienic production and distribution of meat for human consumption.
(2) To promote sound management practices for the production and marketing of healthy animals and their products.
(3) To prevent introduction of animal diseases and pests.
(4) Involvement with Worm-check
(5) Lice check - A program to reduce chemical use in sheep to the minimum necessary to maintain production and to slow the development of resistance.
(6) Footrot control - An extension campaign to reduce the incidence of footrot is proposed.

PLANT SERVICES DIVISION

9. Horticultural Branch

(1) Proposed new initiative - Food Care Program - to promote the production of quality, healthy food.
(2) Program to reduce the level and variability of sulphur dioxide in dried apricots.
(3) General programs concerning horticultural products, quality, post harvest etc.
(4) Monitor and advise re diseases and treatment.
(5) Evaluate new chemicals and spray application methods.
(6) Fertiliser application - advice.

10. Soil and Water Conservation Branch

(1) Efficient use of effluent water on horticultural crops (Bolivar) and ensure safety of the food produced.

11. Field Crop Plant Pathology Unit

(1) Provide diagnostic services re plant diseases, resistance, biological control etc.

12. Plant Nutrition Unit

(1) Promote efficient and cost effective fertiliser usage for field crops.

13. Entomology Unit

(1) To maximise the returns to the State from agriculture by the economic control of pests.
(2) To reduce the use of pesticides in S.A..
(3) Programs of relevance operate in relation to biological control, plant resistance, integrated pest management, chemical control.

14. Weeds Research Unit

(1) Cost effective weed control recommendations for agricultural systems which ensure good agricultural practice, environmental management and human safety.

15. Agronomy Services Section

(1) Programs aimed at promoting sustainable agricultural systems involving crops.
(2) Projects involving grain contamination and chemical residues.
(3) Conduct Aerial Agriculture Technical Workshop annually
(4) Conduct Plant Protection Conference annually
(5) Provide a calibration service for aerial operators in S.A.

16. Grain Legumes Breeding Unit

(1) Production of high yielding, disease and insect resistant grain legumes.

17. Plant Breeding Unit

(1) Improved pasture species which are more disease resistant and require less use of chemicals.

18. Plant Health & Regulation

(1) Legislative control.
(2) Eradication of fruit fly.
(3) Inspection of horticultural produce.
(4) Quarantine and associated inspection.
(5) Seed certification.

REGIONS

19. Northern Region

(1) Monitor cattle diseases.
(2) Fruit fly inspection.
(3) Investigation of incidence of cheesy gland in sheep.
(4) Internal parasites of sheep and cattle.

20. Eyre Region

(1) Increase cereal yield by identifying nutritional, disease and weed problems.
(2) To control plant and animal diseases (Minnipa trials).

21. S.E. Region

(1) To control plant and animal diseases.
(2) Provide diagnostic services (SERVL).

22. Murray Lands Region

(1) To control plant and animal diseases.

23. Central Region

(1) To control plant and animal diseases (Turretfield trials).
(2) Programs on stem rust resistant wheats.
(3) Identification of cereal diseases.
(4) Insecticide residue investigations.
(5) Controlling cape tulip and other weeds.
(6) Control of insects in grain legumes.
(7) Fertiliser selection program.
(8) Monitor efficiency and safety of new agricultural chemicals.
(9) Milk quality investigations.
(10) Comparison of resistant rootstocks for grapes.
(11) Footrot, lice and worm projects in livestock.
(12) Reduced pesticide use on celery, apples.
(13) Pesticide application field days.
(14) Ectoparasite control programs.

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ACRONYMS

The following abbreviations have been used throughout the report. Explanations of technical terms can be found in the Glossary.

AAAA	Aerial Agriculture Association of Australia Ltd
AAVCC	Australian Agricultural and Veterinary Chemicals Council (see also Appendix B)
ABARE	Australian Bureau of Agricultural and Resource Economics
ACAC	Agricultural Chemicals Advisory Committee (see also Appendix B)
ADI	Acceptable daily intake
ASTEC	Australian Science and Technology Council
AVCA	Agricultural and Veterinary Chemicals Association of Australia Ltd
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DARA	Department of Agriculture and Rural Affairs, Victoria
DPIE	Department of Primary Industries and Energy
DPSC	Drugs and Poisons Scheduling Committee (see also Appendices B and C)
FAO	Food and Agriculture Organisation
GMAC	Genetic Manipulation Advisory Committee
GMO	Genetically manipulated organism
IPM	Integrated pest management
MRL	Maximum residue limit
NARM	National Antibacterial Residue Minimisation program
NH&MRC	National Health and Medical Research Council (see also Appendices B and C)
NOEL	No observable effect limit

NOHSC	National Occupational Health and Safety Commission
NRS	National Residue Survey
PACC	Pesticides and Agricultural Chemicals Committee (see also Appendices B and C)
PVR	Plant variety rights
RIRF	Rural Industry Research Funds
SADA	South Australian Department of Agriculture
SCL	State Chemistry Laboratories
TAFE	Department of Technical and Further Education
TCAC	Technical Committee on Agricultural Chemicals (now replaced by ACAC)
TCVD	Technical Committee on Veterinary Chemicals (now replaced by VCAC)
TGAC	Technical grade active constituent
UF&S	United Farmers and Stockowners
VCAC	Veterinary Chemicals Advisory Committee (see also Appendix B)
VMDA	Veterinary Manufacturers and Distributors Association

GLOSSARY

Acaricide	Chemical or agent which destroys or controls ticks and mites.
Acceptable daily intake (ADI)	The daily intake which, during an entire lifetime of exposure at that level, is almost certain not to result in injury.
Active compound	The principle component in a chemical formulation and the ingredient which acts on the pest organism. Same as active constituent or active compound.
Active constituent	The principle component in a chemical formulation and the ingredient which acts on the pest organism. Same as active ingredient.
Active ingredient	The principle component in a chemical formulation and the ingredient which acts on the pest organism. Same as active constituent.
Adjuvant	A substance added to a chemical to modify the physical or chemical characteristics of the preparation, for example wetters, stickers, solvents or synergists.
Aerial agriculture	The use of aircraft to assist in or to perform farming tasks. Includes aerial spraying and aerial seeding.
Aerial spraying	The spray application of chemicals, including pesticides and fertilisers, using aircraft.
Agricultural chemical	A chemical used to improve agricultural production, protect crops or control pests, diseases and physiological condition of crop plants. See page 3 for further information.
Aliphatic pesticides	Pesticides made from open-chain hydrocarbon compounds as distinct from those made from derivatives of benzene, for example glyphosate.
Alternative methods	Integrated and non-chemical methods of pest control, including physical/cultural control, biological control, autocidal and genetic control, host resistance and vaccination. (See pages 69 to 76 for further information.)
Anthelminthics	Chemical or agent which controls or expels intestinal worms.

Antibiotics	Substances which control or destroy bacterial diseases.
Application technology	Technology available for applying chemicals, in particular for applying chemicals in a liquid form. See also application.
Application	Putting or directing a pesticide on, in or at plants, animals, buildings, soil, air, water or any other site. The aim of chemical application is to bring the active ingredient in contact with the pest organism.
Autocidal control	The use of an organism, or some characteristic of an organism, to destroy or reduce the reproductive potential of the same species.
Ballast	Chemical components which are present in a chemical formulation but have no significant or useful function, that is they are redundant.
Biocontrol	Control of one organism by another organism which may or may not be introduced for that purpose. (See page 70 for further information.) Same as biological control.
Biological control	Control of one organism by another organism which may or may not be introduced for that purpose. (See page 70 for further information.) Same as biocontrol.
Biopesticide	The use of organisms such as viruses, bacteria and fungi to destroy or control pests. The organisms used are pathogenic to the pest or in some way interfere with the normal biological pattern of the pest species and can therefore be used to control the pests.
Biotechnology	Biology used in production processes; production processes involving biological organisms. For example, tissue culture, fermentation of micro-organisms, genetic manipulation.
Broad spectrum pesticides	A pesticide that controls or is toxic to a wide range of pests.
Chemical trespass	The movement of a chemical outside the intended target area during or after application. Includes spray drift, water leaching and soil particle movement.
Clearance	Procedure for evaluating the efficacy, safety and acceptability of agricultural and veterinary chemicals prior to registration.

Compliance activities	Any activities, such as monitoring or investigation, designed to ensure compliance with appropriate regulations.
Conventional methods	Established and widespread farming practices, including the use of farm chemicals and other husbandry practices.
Cross resistance	When development of resistance to one pesticide confers resistance to other pesticides.
Economic injury level	The pest population that causes damage equal to the cost of preventing the damage.
Economic threshold	The pest population density at which control measures should be invoked to prevent any increase in the pest population from reaching economic injury levels.
End-use product	A chemical product packaged and marketed for use in agriculture (or similar), as distinct from a chemical which is used as an input to the manufacture of other chemicals or products.
Exotic organisms	Plants, animals or diseases which do not occur naturally in Australia. In particular, those organisms for which it is considered undesirable to have them occur in Australia.
Extension	The dissemination of technical information and knowledge.
Farm chemical	All chemicals for farming, including agricultural chemicals, veterinary chemicals and fertilisers.
Fertiliser	A substance added to the soil to augment plant food supplies. See page 96 for further information.
Formulation	The physical form of the chemical (liquids, dusts, granules etc), including both the active ingredient and any other substances required to maintain the chemical in a readily useable form, such as solvents or propellant gas.
Fungicide	Substance or agent which destroys or controls fungi and fungal disease.
Genetic control	Manipulation of the genetic composition of a pest population in order to destroy or reduce the reproductive potential of the same species.

Genetically manipulated organisms	Any genetically modified organism, and organisms produced by genetic manipulation. Genetic manipulation is the modification or intervention in the hereditary (genetic) characteristics of an organism.
Ground spraying	The spray application of chemicals, including pesticides and fertilisers, using ground based (that is, not aerial) equipment, such as knapsacks or spray units towed by vehicles.
Growth regulator	Substances which alter the growth or development of a plant or animal.
Hazard	The likelihood that a substance will cause an adverse effect under the conditions in which it is used. Hazard is a function of both the toxicity of the substance and the likelihood of exposure to it.
Heavy metal	A metal with a high atomic mass, for example mercury, lead or cadmium.
Herbicide	Substance or agent which destroys or controls unwanted plants.
High analysis fertiliser	A concentrated form of fertiliser.
Host	The organism affected by a pest or disease. For example host crop or host animal.
Host resistance	See Resistance - host.
Inorganic pesticides	Pesticides based on compounds which do not contain carbon as the most important ingredient.
Insecticide	Substance or agent which destroys or controls insects.
Integrated methods	Integrated pest management (IPM) methods for controlling pests. See integrated pest management.
Integrated pest management (IPM)	A pest management system that aims to maintain pest populations to tolerable levels by utilising all suitable techniques and methods in as compatible a manner as possible and in the context of the associated environment. Techniques may include biological control, plant or animal resistance, environmental modification, and may be complemented by synthetic chemicals. The antithesis of IPM is calendar application of broad-spectrum chemicals whether or

	not they are needed. (See pages 46 to 47 for further information.)
Intractable waste	Hazardous wastes (corrosive, flammable, explosive or toxic) which cannot be disposed of via sewerage systems or landfills.
Label	The written, printed or graphic matter on, or attached to, the pesticide, or the immediate container thereof and the outside container or wrapper of the retail package of the chemical.
Major crop/commodity	A widely farmed or valuable agricultural commodity. For example, wheat, beef and wool are all major agricultural commodities.
Material safety data sheets	A document describing the properties and uses of a chemical product and used to provide information required for the safe handling of the chemical in the working environment.
Maximum residue limit	The maximum concentration of an agricultural or veterinary chemical residue that is legally permitted in agricultural produce. The concentration is expressed in milligrams of residue per kilogram of food (mg/kg). See Appendix A for further information.
Microbial control	The use of micro-organisms, such as bacteria, viruses or fungi, to control other organisms or pests.
Minor use	Use of a chemical on a minor agricultural commodity or against a minor pest. A minor commodity is an agricultural commodity which is farmed in only relatively small quantities or in a limited geographic area. A minor pest is a pest which is significant only occasionally or which affects only a small area.
Narrow spectrum pesticides	Chemicals (particularly herbicides and insecticides) which destroy or control target organisms with little or no effect on desirable species in proximity to them. Same as selective pesticides.
Nitrogenous fertiliser	Fertiliser containing nitrogen.
No observable effect level (NOEL)	The highest dose level which produces no observable toxic effect in the most sensitive test species. Expressed as milligrams per kilogram of body weight per day.

Non-active ingredient	Ingredients in a chemical formulation which have no biologically active role, that is they do not act on the pest organism. Non-active ingredients include substances required to keep the active ingredient in a useable form (eg. solvents, aerosols), but may also include impurities.
Non-chemical pesticide	Any substance or agent used to destroy or control pests (pesticide) but which is not a synthetic chemical. Includes many biological control agents and vaccines.
Non-target	Any area, plant, animal or other organism which is not the object of a pesticide application; any species that the pesticide is not aimed at. The term off-target is also used.
Nutrification	Build up of higher than normal levels of nutrients (nitrogen, phosphorus) in water. Can be caused by leaching of fertilisers from soil, or by contamination with sewerage and other organic matter.
Off-label use	The use of a chemical in any way at variance to the instructions given on the product label.
Off-patent product	A chemical for which the patent period has expired and is therefore able to be copied by other manufacturers. The normal patent period is 16 years from the date of application for the patent.
Off-target damage	Damage caused to non-target areas or organisms.
Organic chemical	A chemical based on compounds containing carbon. The term was originally used to refer to a chemical existing in or derived from living organisms.
Patent product	A product based on a chemical formulation which is still under patent.
Persistence	The length of the active life of a chemical, or the length of time required for the chemical to decompose or to be metabolised.
Pesticide	Any substance or agent which is used to destroy or control any form of unwanted (pest) plant or animal life. The term includes both agricultural and veterinary chemicals used to destroy or control pests.
Pesticide resistance	See Resistance - pesticide.
Plant protection	The science or activity of protecting plants and crops

	against attack by diseases and pests.
Registered use	The specific use(s) for which a chemical has been registered. The use has therefore been assessed during the clearance and registration processes. Registered uses appear on the product label.
Registration	Agricultural and veterinary chemicals must be registered prior to sale in all States. Details of formulation, safety, effectiveness and environmental acceptability are considered prior to registration being granted. Claims and directions for use are also subject to registration requirements.
Residue (chemical)	A residual deposit of a chemical, its metabolites or its break-down products.
Resistance - host	Inherent ability of a host plant or animal to resist attack by a pest.
Resistance - pesticide	The development of a strain of pests to tolerate doses of a pesticide which would prove lethal to the majority of individuals in a normal population of the same species.
Selective pesticides	Chemicals (particularly herbicides and insecticides) which destroy or control target organisms with little or no effect on desirable species in proximity to them. Same as narrow spectrum pesticides.
Spray drift	The movement of airborne spray particles or droplets beyond the intended target area.
Synthetic chemical	A manufactured chemical, as distinct from chemicals of natural origin.
Target	An area, building, animal, plant or pest which is to be treated with a pesticide.
Target specific pesticide	A pesticide which acts specifically on the target organism and does not act on desirable species in close proximity.
Technical grade active constituent	An active ingredient at commercial (not analytical) grade for use in formulating end-use products.
Toxicity	The degree to which a substance is poisonous to a plant or animal or the ability of a substance to cause poisoning. The effect may be permanent or transient.

See page 62 for further information.

Traceback	Tracing of a residue, disease or any other condition back to the property of origin and/or source of contamination.
Vaccine	A substance administered to increase immunological resistance to disease.
Veterinary chemical	A chemical used for the treatment and protection of animals and in supplementing their diet. Also referred to as stock medicines or veterinary drugs. See page 3 for further information.
Violative residue (chemical)	A chemical residue which exceeds the maximum permissible level or maximum residue limit.
Withholding period	The minimum interval that should elapse between the last application of a chemical to any crop, pasture or animal and the harvesting, grazing or slaughtering of the crop, pasture or animal, or the collection of milk and eggs for human consumption.