



Report 47 part 1: beginning -
up to and including page 45.

DEPARTMENT OF AGRICULTURE, SOUTH AUSTRALIA

Agronomy Branch Report

PRINCIPLES, PRACTICES & NEW DEVELOPMENTS

IN PLANT PROTECTION

April, 1973.

Report No.

47.

SOUTH AUSTRALIAN DEPARTMENT OF AGRICULTURE

AGRONOMY BRANCH MINI-CONFERENCE

PRINCIPLES, PRACTICES & NEW DEVELOPMENTS
IN PLANT PROTECTION

Organising Committee

Mr. G.B. Baldwin, Senior Weeds Officer
Mr. P.B. Birks, Senior Research Officer
(Entomology)
Dr. A. Dube, Senior Plant Pathologist

Report No. 47

April, 1973

AGRONOMY BRANCH MINI-CONFERENCE

- INDEX -

SECTION I: PESTICIDES, PROBLEMS & POLICIES

Page

Public hysteria and social conscience concerning use of pesticides. (Extracts from this paper were presented at the conference.) 1

Mr. J.T. Snelson - Commonwealth Pesticides Co-ordinator,
Dept. of Primary Industry.

Health problems associated with the use of pesticides. 19

Mr. R.C. McCarthy - Senior Pharmaceutical Inspector,
Dept. of Public Health.

The complexities of Pest Control and Wildlife Conservation. 31

Dr. B. Shearer - Dept. of Environment & Conservation.

Procedure for clearance and registration of new agricultural chemicals. 35

Mr. B.D. Robinson - Technical Adviser.

SECTION II: PLANT PROTECTION WITHOUT HERBICIDES

Farm Hygiene

The Place of cultural and rotational factors in plant protection. 38

Mr. G.D. Webber - Acting Senior Agricultural Adviser.

Farm hygiene and grain pest control 43

Mr. P.R. Birks - Senior Research Officer (Entomology).

Farm hygiene and weed control. 46

Mr. G.B. Baldwin - Senior Weeds Officer.

Biological Control

Sitona weevil parasites and resistance. 51

Mrs. J. Moulden - Research Officer (Entomology).

Biological Control of Skeleton Weed.

Mr. M.J. Catt - Research Officer (Weeds).

New concepts in insect control.

Mr. P.B. Birks - Senior Research Officer (Entomology).

Resistant Varieties

Use of resistance in control of plant pathogens.

Mr. A.H. Mayfield - Research Officer (Plant Pathology).

SECTION III: NEW DEVELOPMENTS

New developments in the horticultural usage of agricultural chemicals.

Mr. R.L. Wishart - Senior Horticultural Adviser.

Spray seed, an I.C.I. technique.

Mr. M. McKay - Market Development Officer,
I.C.I. Australia.

Ultra-low volume spraying, a new tool for insect control.

Mr. P.R. Birks - Senior Research Officer (Entomology).

SECTION IV: THE APPLICATION OF PESTICIDES

Calibrating ground spraying equipment.

Mr. N.R. Matz - Agricultural Adviser.

The agricultural pesticide market, and the role of the re-seller in ensuring proper application.

Mr. P.S. Gurner - Director, Agr. Chem. Pty. Ltd.

Fumigating with phostoxin on the farm.

Mr. J.A. Wright - Managing Director,
Phostoxin, Aust. Pty. Ltd.

Aircraft spray equipment and the place of aircraft in pesticide applications.

Mr. J. Freeman - Managing Director,
Trojan Aerial Spraying Co.

57

62

71

75

83

86

90

95

97

SECTION V: PRACTICE MAKES PERFECT

No report of this session has been included.

Practical demonstrations were held of the following:-

Calibration of a low volume boom spray.

Mr. C.R. Alcock - Local Govt. Liaison Officer.

Calibration of an ultra low volume and standard misting machine.

Mr. C. Phillips - Technical Officer (Entomology)

Handling of a pesticide spill.

S.A. Branch Agric. Vet. Chem. Assoc.

Demonstration of different pumps and types of protective clothing.

Mr. R. Moulds - Safety Officer

Mr. K. Smith - Technical Officer (Weed Control)

Mr. N. Brooks - Field Officer

SECTION I

PESTICIDES, PROBLEMS & POLICIES

AGRONOMY BRANCH MINI CONFERENCE

PUBLIC HYSTERIA AND SOCIAL CONSCIENCE

CONCERNING USE OF PESTICIDES

by

J.T. SNELSON

Pesticides Co-Ordinator
Department of Primary Industry

Much scientific literature and experience has been accumulated which is unfortunately often not considered when people campaign to influence public opinion against modern chemical tools.

Biological problems, particularly those with a sociological or ecological slant, are notoriously open-ended - there is no single, incontrovertible solution. Parameters may be difficult to identify, variables impossible to quantify with an acceptable degree of precision. All this leaves room for judgement, experience, flair, father-knows-best, good-of-the-people-at-heart, and plain prejudice, bias and even mischief. The individual, struggle as he may, is in a difficult situation. He may not have access to all the current information, he may not be trained (educationally biased?) in the particular field concerned and he will in any case be influenced by the particular environment in which he works. Caught in such a dilemma, what could be easier for him than to join one gang or the other? Just as there are only two sides to a fence, so people usually divide into two groups on any one problem, the 'pro' and the 'anti', 'them' and 'us'.

The use or misuse of pesticides is one socio-biological problem that has generated interminable controversy, a great deal of it ill-formed, much of it biased and far too much of it surcharged with emotion. If the bases of involvement were the sole determinants of attitude, an individual could readily be labelled according to his scientific discipline or his professional, vocational or leisure interests. A chemist and a farmer would be 'pro', and ecologist and a trout fisherman would be 'anti'. But this is much too simple. The plain of cleavage cuts through almost all groups, even if, statistically, there are significant intergroup differences.

It begins during World War II when a safe, cheap and potent new insecticide made its debut. Known as DDT, it proved its value almost overnight. Grain fields once ravaged by insects began producing bumper crops. Marsh-land became habitable. And the death rate in many countries fell sharply. According to the World Health Organization, malaria fatalities dropped from four million a year in the nineteen thirties to less than a million by 1968. Other insect-borne diseases also loosened their grip. Encephalitis. Yellow fever. Typhus. Wherever DDT was used, the ailment abated. It has

been estimated that a hundred million human beings who would have died of one of these afflictions are alive today because of DDT.

But that's not the whole story. In many countries, famine was once a periodic visitor. Then, largely because of food surpluses made possible by DDT, famines became relatively rare. So you can credit this insecticide with saving additional hundreds of millions of lives.

Then in 1962, a lady named Rachel Carson wrote a book called "Silent Spring", in which she charged that DDT had killed some fish and some birds. That's all the Disaster Lobby needed. It pounced on the book, embraced its claims -- many of them still unsubstantiated -- and ran off to Washington to demand a ban on DDT. And Washington meekly gave them their ban, in the form of a gradual DDT phase-out. Other countries followed the U.S. Lead.

The effects were not long in coming. Malaria, virtually conquered throughout the world, is having a resurgence. Food production is down in many areas. And such pests as the gypsy moth, in hiding since the nineteen forties, are now munching away at American forests.

In some countries -- among them Ceylon, Venezuela and Sweden -- the renaissance of insects has been so devastating that laws against DDT have been repealed or amended.

The tragedy is that DDT, while it probably did kill a few birds and fish, never harmed a single human being except by accidental misuse. When the ultimate report is written, it may show that the opponents of DDT -- despite the best of intentions -- contributed to the deaths of more human beings than did all of the natural disasters in history.

Pesticides have been, are and will continue to be major weapons in man's battle against world hunger. Even with continued advances in biological and other alternate control measures, agricultural chemicals will still perform a vital role in attaining the needed food production, especially in developing countries.

At present growth rates, world population will reach an estimated 7 billion by the end of the century, with four times as many people in the developing countries as in the developed ones. In order to feed this many people, the world's agricultural production will have to double in the same period of time.

Control of pests is a must. Disease, insects and weeds cause heavy tolls in production. In tropical and subtropical countries, for example, losses due to pests are at least 10 per cent greater than in developed countries, where they are estimated at 25 per cent.

There are pest problems today for which no satisfactory control methods exist to replace the use of chemicals and, chemical pesticides will be the most dependable weapon of the applied biologist unless and until more acceptable techniques can be developed.

The use of pesticides has been accompanied by several ironies. They have been a major contributor to the upsurge in agricultural productivity over the past three decades. But from this productivity came the great surpluses. The use of pesticides to eradicate disease-carrying insects throughout the world has sharply reduced the death rate and thus has been a substantial factor in the population explosion.

The concern is with the irony that pesticides could constitute a potential hazard to our health and are capable of contaminating our environment. Chemical pesticides kill pests because they are toxic, and because they are toxic some are also capable, in excessive dosages, of causing illness, even death, in people and wildlife.

But just as it would be illogical to prohibit the use of chemical pesticides in an attempt to increase farm prices or as a mean of controlling the population explosion, no one should propose that pesticides be banned, so as to assure that not a single individual is made ill nor any wildlife affected because of an excessive exposure to a toxic chemical.

1. The Benefit - Risk Equation

Man aspires to continually improve his lot and from his creative genius has come a parade of innovations, and civilisation has advanced. But virtually each benefit innovation has its attendant risks; modern drugs save millions of lives but some people have died because of them, the automobile kills and maims but it has changed our lives generally for the better. Thus, society is continually faced with the task of balancing benefits against risks.

The concept of the benefit-risk equation has a compelling logic which all accept in principle. But going from principle to practice always is attended with disagreement and conflict. This occurs because a diverse society generates a diverse range of material and aesthetic interests and values. Conflict occurs even though all concur with the ultimate goal of the promotion of the public good.

Although all of us are consumers and all have a stake in an expanding and prosperous economy, our attitudes on pesticides and their regulation differ. The wildlife conservationist and the chemical manufacturer approach the subject from different perspectives. The housewife buying processed foods at the supermarket has different concerns than the farmer who grows the food.

Differing interest generate disagreements but the sharpness of these disagreements often varies inversely with the quality of available empirical data needed to evaluate alternative approaches and the general awareness of that information.

This principle was illustrated by two events. The first was the publication (in the summer of 1962) and the public reaction to the book "Silent Spring" by the late Miss Rachel Carson. Second was

the discovery and subsequent controversy which attended the Mississippi River fish kill in the fall of 1963. "Silent Spring" brought forth a great expression of public anxiety over chemical pesticides in our environment. The Mississippi River fish kill served to dramatise Miss Carson's foreboding prophecy of an impending silent spring.

It seems to matter little that the fish kill, originally attributed to pesticides was later shown to be caused by heavy siltation of the water due to extremely heavy rain.

Because of such events, the general public became aware, really for the first time, of chemical pesticides and their widespread use. Because of the character of these and related events, this public awakening focused first on the risk side of the equation. Fearing the worst, some people agitated for severe curtailment in pesticide use, implying that they should be virtually banned.

Prevention of the use of DDT has been made the target of a powerful propaganda drive in certain prosperous countries because, it is stated, DDT is a danger to man and harms wild life. On the other hand, DDT is by far the most economical, effective and safe insecticide for many uses, particularly for protecting men from certain insect-borne diseases and for enabling cotton to be grown in poor countries. Some risks can be reduced by eliminating those uses of DDT for which adequately safe, economical and effective substitutes exist, whether chemical or not; other risks can be reduced in other ways. The known risks to men are trivial, except when DDT concentrate is deliberately drunk, and the scare is made up of unknown risks - which could equally exist with any object or material, new or old. Risks to wild life have been greatly exaggerated and scares depending on falsehoods have become current. The postulated threat of progressive accumulation of DDT along a long food chain is not adequately supported by evidence, much of which has been misinterpreted.

Thus the main dilemma is how to balance the great and undoubted benefits of DDT to millions of men, women and children against harm to wild life, sometimes genuine and remediable and sometimes dubious.

People who campaign for banning have possibly failed to recognize this dilemma. On the other hand, they may have made a deliberate choice in favour of wild life. In that case, to be logical, they should also appose all other means of preventing premature death of other people, which they might justify as a means of postponing over-population. The use or abuse of DDT is a minor problem compared with the rise of the world's population.

Agriculture is the world's major industry. In 1965, 52 per cent of the world's population was dependent on it for its livelihood. To disrupt such an essential bulwark of the world economy by denying it one of its essential inputs - pesticides - would clearly be to court disaster and to imperil the living standards of tens of people, many of them in the Third World. And in industry where farm labour is becoming increasingly scarce,

des is an important factor in enabling farmers to market, at a reasonable price, the high quality produce expected by the modern housewife.

The effects of banning or restricting pesticides in a highly developed country can also be gauged by an example from the Agriculture Committee Pesticide Report to the Great Lakes States' Governors in the U.S.A.

"Stopping the use of pesticides in the Lake States would reduce the value of agricultural production by over \$1½ billion annually. Of this, loss from eliminating insecticides would account for over \$650 million, from eliminating herbicides for weed control over \$635 million, and fungicides for plant disease control over \$230 million. The impact on the total economy would be manyfold larger.

"The benefit to risk ratio in using registered pesticides as recommended is definitely documented in favour of these pesticide uses."

The control of certain insect-borne diseases has only become possible with the introduction of modern insecticides. In the case of malaria, their use has saved millions of lives and enabled whole populations to work more actively, with great economic benefit. The world annual death rate from malaria has been reduced from six million in 1939 to two-and-a-half million today. Similar progress has been made in controlling other important tropical diseases such as yellow fever, sleeping sickness and 'Chagas' disease.

Pesticides, like virtually every chemical, may have physiological effects on other organisms living in the environment, including man himself; whether the effects occur or not is simply a question of the dosage and of proper use. There are numerous examples of substances which are needed by plants and/or animals, but which in overdoses are poisonous: common salt, some heavy metals and various trace elements spring readily to mind. The majority of the established pesticides have no adverse effect on man, animals or the environment in general, so long as they are used only in amounts sufficient to control the pest organisms; but they can be harmful in excessive amounts.

One is left with the impression of Rachel Carson's followers fighting a holy war for the survival of mankind against the pesticide manufacturers who are intent only in becoming rich at the expense of the health and welfare of the human race.

I would submit that the true picture is a very different one and it is time that the records were set straight. It is not only in the public health field that pesticides have made their impact. In Australia even with an annual expenditure of \$50m. on pesticides we lose about 23% of the possible yield of our farms (around \$920 million). Without pesticides the loss would be over \$1,500 million.

Preventing staggering losses to crops and livestock from disease, insects, weeds, and all pests is the role played by agricultural and veterinary chemicals. A most informative and thorough study carried out by Bayer Leverkusen Ltd., found that the potential cereal crop in Australia and New Zealand in 1967 was \$1,700 million. But the actual crop was \$1,230 million, indicating that crop losses for the year totalled \$470 million. A break-down of those losses was revealing: \$120 million attributed to insects; \$210 million to plant diseases; \$140 million to weeds. Agricultural industries could require no further proof of the need to prevent astronomical losses. A similar study of the animal production industries could well reveal similar, or even greater, losses. Prevention of such disasters is needed if true efficiency is to be understood.

These figures merely support what farmers and graziers have known for decades - that the rural industries would be more remunerative without pests; that Australia and New Zealand could produce more food for the world if farmers could control crop and animal pests. They have the choice of mechanical means and chemical means. Farmers and graziers are quickly realising that in many areas the adoption of chemical warfare against crop and animal pests is the major management aid in winning the battle against this ever-increasing menace.

I would add that one rarely sees mention of the fact that over 500m. people in the world are no longer exposed to the threat of malaria because of DDT. But how many authors of articles appeared to rejoice in the fact that Sweden had banned DDT - and much more significant, how few printed the news that it had to be reintroduced after a few months to protect that country's forestry interests. I am convinced personally that DDT could be used for nearly all the purposes for which it has been used for many years without any untoward effects. I agree that we should collect more data particularly about a few predatory bird species because we need much more information before soundly based judgments about banning such a beneficial compound can be made. It has been said "No one will dispute the axiom that we must know as much about the risks of pesticides as we know about the benefits. However, the risks must be determined by competent research and judged by knowledgeable scientists, not assumed by emotional authors and judged by ambitious politicians."

The news items referred to earlier, prompt me to ask why those responsible for putting out such items whether for the written or spoken word invariably phrase them so that people who don't know the subject are made much more apprehensive than they need be. One asks in perplexity rather than anger what they hope to achieve by it. Is it that news has to be sensational and frightening rather than accurate and objective? In the scientific literature, accuracy and objectivity are all important or one is torn to pieces by one's peers. And I mean the scientific literature with papers written by practising scientists.

I don't mean magazines with quasi scientific names, where the articles are written by people posing to be scientists but incapable of carrying out a proper experiment let alone being objective.

Apart from the scientific literature, it seems that impact and effect are all important and that accuracy hardly comes into it.

2. Pesticides and the Total Environment

During the past 5 years there has been an increasing awareness of the potential problems associated with widespread use of pesticides. Because of public studies much information heretofore only available to the scientific community has reached the public at large, and initial public anxiety has been replaced by greater public confidence. This calmer atmosphere is justified and desirable, but it does not mean that public concern has disappeared. For while the public has come to recognise that the benefit-risk equation is adequately balanced at the present there has been a deepened recognition of the type of serious questions that must be dealt with in the future.

The public debate over pesticides is but one facet of a wider debate which reflects a greater sensitivity to the fundamental questions raised by the continuing and accelerating pace of man's modification of his total environment. Pesticides are but one factor and we are increasingly aware that our environment is being altered even more dramatically by air and water pollution, atomic fallout, and the population explosion.

These are manifestations of the great issues of our time - man's relationship to the world around him. As we come to appreciate more keenly the significance of this vast, accelerating alteration of our environment we recognise the need for stock-taking and the necessity of endeavouring to take into account all the multitude of complex relationships between man and his natural and artificial surroundings.

This broadening in our vision is most desirable and is to be encouraged. In this connection the term "ecology" has been used frequently throughout this report. Ecology derives from the Greek word oikos, meaning "house" or "home". Its modern dictionary meaning is "biology dealing with the mutual relations between organisms and their environment". It is unfortunate that we so often spoil the meaning of words so that they become trite and suspect. It is possible that this is the case with ecology, because for many it has been distorted to a connotation of naturalism. No such meaning is given to the term in this paper. Rather, its use is intended to help convey something of the idea of the multitude of complex relations between all living organisms, including man, and the environment and to encourage a greater effort to broaden our vision as we look to the future. Man cannot live alone and apart from nature, and his interdependency is psychological as well as physical.

By suggesting a greater emphasis on the ecological approach in future research I intend no rigid point of view. Precisely the opposite. By emphasizing man's relationship to his total environment, research horizons are expanded, not restricted. This broadening of our vision will force an expansion of the list of factors to be accounted for in our research programs and policy formulations. But at the same time it will sharpen our perspective of the public questions with which we must come to grips.

Sound judgments must be made. A biased conservationist and an equally biased pesticide manufacturer have great difficulty in making a sound judgment in the area of pesticides and environmental quality. The judgement must be based on evidence, not environmental emotion or increased profit potential. Hopefully, the evidence will be objective in establishing the degree of benefit or risk to mankind. This is a call for reason over emotion on both sides of the issue.

However, the real question is "Do we want to change the basic standards regarding food and health in this country?". Pesticides are necessary to produce the quantity and quality of food required for our growing population. Pesticides are necessary to provide for the protection of health, including those pesticides that make recreation more enjoyable by reducing mosquito and fly populations.

We, as citizens, have to evaluate the alternatives and determine how far we want to go. We can go from a no-pesticide situation to a selection of one, two, three or more. It is a case of measuring the benefits against the risks. It is a case of making judgments relating to what we determine are acceptable standards.

The quantity and quality of empirical information as to both the benefits and risks of chemical pesticides available to scientists and administrators in Government agencies, academic institutions, and private industry is far more extensive than is generally recognized. Thus, predictions of impending disaster arouse great anxiety not because there is insufficient evidence available to challenge these prophecies, but because the public is simply not sufficiently aware of the existence of this information.

And now I leave this perspective and turn to that of the Government. I doubt if there is a Government view but there are several rather specific views, all of them carrying a common theme. The Government has the responsibility for safeguarding the community and while it welcomes advances and new techniques it has to be sure that they are not accompanied by any hazards, seen or unseen, to which the populace would be exposed.

3. The Political Factor

Politics will play a major role in the future of pesticides and environmental quality. Each and every one in this room can influence the decisions affecting pesticides and environmental quality.

The pesticide industry has been portrayed in the press as a "bad guy" because it makes use of the recourses available in the laws regulating pesticides. In our system, we believe in checks and balances. Chemical pesticides, in spite of much clamor, are probably more highly regulated than any other items entering commerce. There are laws and regulations relating to labelling, packaging, transporting, applying, using, disposing, and residues on food. We think they should be regulated because of their nature. We argue for uniform legislation which is a must.

Most pesticide manufacturers have other business interests as well as pesticides. I think it would be unfortunate if, because the pesticides business became increasingly unattractive on account of antagonistic and restrictive trends and increasing costs of research, investment in it became too unattractive. Unfortunate would be the understatement of the day.

I think, therefore, that the pesticide industry has a duty, not only to itself but also to the community, to educate public opinion and those who influence it, of the benefits which derive from pesticides on the one hand and the seriousness and care with which the industry undertakes its responsibilities on the other.

4. Herbicides

Weeds, both grassy and broad-leaved, compete with crop plants for light, space, water and nutrients. In some cases they act as hosts to bacteria, fungi, animal pests and viruses, and they also hamper mechanical harvesting operations. Cultural weed control measures, such as hand weeding, hoeing, harrowing, and other practices including crop rotation and fallowing, are as old as agriculture itself. Over the past 30 years, chemical weedkillers, or herbicides, have largely replaced mechanical methods of weed control, especially in countries with intensive and highly mechanized farming. They provide a more effective means of weed control than the older methods, and, together with fertilizers and improved plant varieties, they have made an important contribution to the increased yields now being obtained, and are going far to combat rising costs and scarcity of labour. It is no exaggeration to claim that fully mechanized farming of cereals, maize, sugar cane, cotton and potatoes would have been impossible without the help of herbicides.

In addition to their use in agriculture, herbicides are used in locations such as industrial sites, railway tracks

and power lines to remove unwanted vegetation which may cause damage or present a fire hazard.

Losses in crop yield as a result of weed infestations can be very heavy and reductions of 20-40 per cent are common. Estimates of losses were most fully described at the FAO Symposium on Crop Losses held in Rome in 1967. Examples of the range of losses (depending on the crop and climatic conditions) in four major countries are as follows:-

India	30-100 per cent
U.S.S.R.	20-40 per cent
U.S.A.	8-24 per cent
U.K.	6-50 per cent

These figures well illustrate the effect that weeds can have in reducing potential food supply.

4.1 Benefits of herbicide use

Up to now, the main use of herbicides has been in the more highly developed countries in North America and Europe and in Japan, because of the shortage and high cost of labour. In fact, the intensive and highly productive agriculture of these areas would hardly be possible without herbicides. As labour becomes scarcer and more costly in other parts of the world, the use of herbicides will make an increasingly valuable contribution to maintaining - indeed increasing - agricultural production in the developing countries, especially if high yielding varieties are used more widely.

One example will serve to show the kind of increases which can be achieved by using herbicides. In Canada, expenditure of about \$6 million on herbicides for the treatment of 12 million acres increased the value of the crop harvested by \$32 million.

4.2 Effects on health

Herbicides are, as a class, generally of low mammalian toxicity when properly used; furthermore, they seldom present a consumer hazard because they are either applied very early in the life of the crop or only to the weeds.

Herbicides such as 2,4-D, MCPA, 2,4,5-T and many others of similar composition have been used world-wide for many years with no adverse effects on human health. Recently, however, 2,4,5-T, a herbicide used mainly for the control of woody perennial weeds of pasture and forestry came under strong suspicion in the U.S.A. because certain samples were found, in experiments, to have an adverse

toxicological effect. It was discovered that this was due to an excessive amount of an impurity, tetrachlorodioxin, which, in these particular samples, exceeded by some three hundred times the maximum amount (0.1 parts per million) that is now found in commercial samples of this herbicide. This is not considered hazardous.

The toxicity of most herbicides to mammals and birds is so low that no important direct effects on wildlife would be expected - nor, indeed, have they been observed. As regards the larger living organisms in the soil, a considerable amount of work with a number of herbicides has shown no adverse effect on creatures such as earthworms, mites and insects.

5. Teratological Potential of 2,4,5-T

The herbicide 2,4,5-T has received more notoriety and probably has been the cause of more public concern than any other pesticide except the insecticide DDT. Early in the Vietnamese war, 2,4,5-T, together with several other herbicides, was extensively used as a defoliant to reduce the likelihood of ambush in areas where dense undergrowth in the forests and swamplands of Vietnam favoured guerilla warfare. During June and July of 1969 a South Vietnamese newspaper reported that there had been an increase in human birth defects in some parts of the country. The suggestion was made that this increase was somehow related to the use by the United States Armed Forces of defoliant chemicals.

These reports of possible teratogenic effects in Vietnam might have gone unnoticed had they not been followed in October, 1969, by the announcement of Dr. Lee A. DuBridge, then the President's Science Advisor, that use of 2,4,5-T in the United States was soon to be restricted by certain government agencies. The announcement was a consequence of the release a few days earlier of the results of a study of a number of pesticides and industrial chemicals by Bionetics Laboratories which indicated that mice treated during early pregnancy with large doses of 2,4,5-T gave birth to malformed offspring.

Dr. DuBridge's announcement, together with the Vietnam newspaper report that human birth defects had possibly resulted from exposure of pregnant women to this herbicide, had widespread repercussions. During the following months a veritable epidemic of high level discussions occurred between government-sponsored panels of experts; commissions set up by scientific societies; conferences of scientists from universities; chemical industries and the government; and even a sub-committee of the U.S. Senate. These sundry groups discussed the matter at length but were unable to resolve the main issue of whether 2,4,5-T, as currently produced and used, represented a real risk for human pregnancy.

The question remained unanswered in January, 1971, at which time it was inherited by the newly formed Environmental Protection

Agency (EPA). During the previous year government restrictions had been placed on the use of 2,4,5-T, both for military purposes in Vietnam and for several types of use in the United States that, it was thought, might result in exposure of pregnant women.

One of EPA's earliest functions was to activate in January, 1971, a Scientific Advisory Committee which was charged with responsibility to review all available evidence on the teratogenic potential (capacity to cause birth defects) of 2,4,5-T and to recommend any courses of action that would seem to be indicated by the scientific data. A nine-man committee was selected from a list of scientists submitted by the National Academy of Science, and regarded by the Academy as having appropriate qualifications.

In May, 1971, a 75-page report was submitted to William D. Ruckelshaus, who had a few months earlier, been appointed Administrator of the EPA. The report represented a consensus of agreement reached by all of the nine-man Committee except for one member. The dissenter was Dr. Theodore Sterling, the only member not a qualified bio-medical scientist, who asked to append a lengthy list of objections and exceptions to the main report.

Almost immediately the report was leaked to two scientific new magazines (Nature and Science) in spite of the fact that the regulations under which the Committee operated specifically prohibited any release until definitive action had been taken by the EPA. Highly critical magazine articles appeared during the summer based almost exclusively on the objections and exceptions of the one dissenting member. No more than passing reference was made to the conclusions and recommendations of the eight toxicologists, teratologists, botanists and biochemists who had concurred in the main report.

By all appearances the person or persons behind these distorted magazine accounts hoped to destroy the credibility of the Report and arouse prejudice in the minds of scientists and the public before the EPA had an opportunity to examine it in any objective way, much less take carefully considered action. The only action EPA has taken to date, has been a news release by Mr. Ruckelshaus on August 9, 1971, stating, "A public hearing will be held in the fall to obtain additional facts on 2,4,5-T while the cancellation order continues on the use of the herbicide on food crops grown for human consumption." No public hearing has yet been scheduled.

If it was the intent of the persons who leaked the report to discredit it before its legitimate release, this objective was only partially achieved. In the first place the magazine reports were so flagrantly biased that even readers unfamiliar with the subject could hardly miss the selective editing of the contents of the report. The careful and justification of conclusions pres

were neither quoted nor discussed. On the other hand, most of the objections and criticisms of the one dissenting committee member were reported in as favourable a light as the writer could manage, despite the fact that these objections were based on little more than personal opinions and subjective reactions. One of several unfortunate consequences may be that the reliability of scientific journalism will remain in doubt in the minds of many readers. Although letters were written to the magazine principally involved, objecting to the overt bias and unfairness of the articles on the 2,4,5-T Advisory Committee Report, the only letter yet to be published was that signed by the entire membership of the Council of the Society of Toxicology. The protest of a panel so highly qualified to pass judgment could hardly be ignored, nevertheless, the letter of the Council was delayed several months before it was printed. (Science, Nov. 5, 1971).

But what about the main issue - is 2,4,5-T really teratogenic? The answer is yes, but so are hundreds of other commonly used drugs, plant products and environmental chemicals (Table 1, p. 18.) These compounds were given to pregnant laboratory animals in doses usually greatly in excess of that equivalent to the human therapeutic dose, in the case of drugs, or of the likely exposure level, in the case of environmental chemicals. This list of chemicals now known to be teratogenic in rats, mice or rabbits is so extensive that it is quite natural to ask if not all chemicals might be damaging to embryonic animals under the right conditions. As a matter of fact, investigators in the field of teratology tend to assume that this is indeed the case. One of the widely accepted principles in the field is called Karnofski's Law, which states, "that any drug administered at the proper dosage, at the proper stage of development, to embryos of the proper species, will be effective in causing disturbances in embryonic development."

Why then, if most pesticides are likely to be teratogenic at high doses, did so much excitement follow the report in 1969 that 2,4,5-T at high doses caused malformations in mice? The answer is not entirely clear, but it probably relates to all of the following conditions:-

- (1) the high level of emotion that surrounded all aspects of the Vietnam War,
- (2) the unsubstantiated report that human birth defects had resulted from defoliation in Vietnam, followed within a few weeks by the report of the teratogenic effects of 2,4,5-T in mice,
- (3) the widespread public concern about many aspects of environmental change and their effects on "ecology",
- (4) over-zealous and sometimes irresponsible efforts by some agencies and individuals to influence public opinion for

personal gain, or for sincere but ill-founded reasons.

Now I would like to speak directly to the subject of the teratogenic potential of 2,4,5-T. The Advisory Committee agreed in a ratio of 8:1 that acceptable data on the embryo-toxicity of 2,4,5-T were available for 6 mammalian species: namely, mouse, rat, hamster, rabbit, sheep and rhesus monkey. None of these showed adverse effects at a dosage of 40 mg/kg/day during the period of organogenesis. The mouse was the most sensitive of the species studied, showing a low level of teratogenicity, mainly cleft palate, at 100 mg/kg/day given throughout organogenesis. Hamster and rat required higher dosage to obtain comparable effects. It was thought likely that all species could have been caused to show embryotoxicity if 2,4,5-T dosage had been raised high enough. For example, pregnant rats given a single dose of 200 mg/kg on day 9, the most susceptible time for teratogenesis in this species, caused modest increases in the percentage of malformed survivors as well as in percentage of intrauterine death.

The dioxin contaminant 2,3,7,8-tetrachlorodibenzoparadioxin (TCDD) has also been shown to have a low teratogenic potential at doses in excess of 0.001 mg/kg. This dosage level is virtually impossible to achieve with currently produced 2,4,5-T which rarely exceeds 0.1 ppm and usually contains much less.

Careful scrutiny of the reports of adverse effects on human reproduction after use of 2,4,5-T as a defoliant in three separate locations, namely, Vietnam, Globe, Arizona; and Swedish Lapland, yielded no acceptable evidence that the alleged effects were related to exposure to 2,4,5-T. It was concluded that, as currently produced and as applied according to the regulations in force - in U.S.A. prior to April, 1970, 2,4,5-T represented no hazard to human reproduction.

Kearney and associates at the U.S. Department of Agriculture have reported that TCDD is immobile in soils, not readily taken up by plants, subject to photodecomposition, persistent in soils and slowly degraded in soils to polar metabolites. "Subsequent studies revealed that environmental contamination by TCDD is extremely small and not detectable in biological samples."

Woolson and associates from several governmental agencies found no dioxin residues in eagle samples from various geographical regions of the U.S. or in soil samples after application of 2,4,5-T in total amounts of 912 lb/acre over the span of 7 years.

These and other data have become available since the Advisory Committee submitted its report. The new information in large measure represents refinements and moderate extensions of information that was already available, or could reasonably be deducted from data examined by the Committee. In any event, the new data do not indicate that a single one of the recommendations made in the original would need to be changed if the report were re-written today.

This is probably reflected in a news item in the Ottawa Journal of Dec. 6, 1971, to the effect that the Canadian Government has begun to relax the restrictions placed on the use of 2,4,5-T. It was stated that "Starting next year, manufacturers who produce 2,4,5-T with a dioxin content of less than 0.5 ppm will be able to sell their products without the warnings - now required on all 2,4,5-T labels." An interesting commentary on the situation in the United States is contained in the same article. "The controversy about the applicability of animal tests to humans still rages, particularly in the U.S. where the herbicide's use has political overtones." In fact, the article makes clear that the Canadian Government is ready to adopt essentially all of the recommendations set forth in the Report of the 2,4,5-T Advisory Committee. Unofficial reports indicate that restrictions of the use of 2,4,5-T may also be relaxed in 1972 in Sweden and Finland.

6. Amitrole - Accused of Carcinogenic Hazard

One of the first and most far reaching blunders that triggered off national and international hysteria concerning pesticides was the cranberry fiasco in 1959.

Certain U.S. cranberry growers plagued with weed problems used aminotriazole, a well known and registered herbicide, on weeds in the bogs where they cultivated cranberries. A zealous official, recognising that there was no legal tolerance for residues of amitrole in cranberries had some analysed and sure enough small traces of the substance were found. He released the information to the news media just on the eve of Thanksgiving, along with the opinion that amitrole was a "carcinogen" (though even in 1973 this is still not proven). The incident filled the news for weeks. No one would buy cranberries and the industry was virtually destroyed. The government paid compensation exceeding \$60 million but it took over 10 years to rejuvenate cranberry growing.

In spite of extensive research data presented, the authorities were unable or unwilling to reverse the decision and amitrole became known as a "potential carcinogen". Following extensive legal argument - not including the study of new toxicological data - the U.S. Environment Protection Agency decided last year that amitrole should not be used on food crops or land used for food production.

The reason for the U.S. decision is the Delaney Amendment to the Food Drug and Cosmetic Act which says in effect that the addition to food of any substance capable of causing cancer in man or animals is not permitted. Though not intended to apply to the minute traces of contaminants which may be found in food by sensitive analytical methods or to residues of pesticides, an interpretation given several years ago now makes such materials subject to the prohibition.

Extensive studies have revealed that food crops weeded with amitrole do not contain residues at or above the limit of determination of 0.02 ppm. These studies have shown no trace of residues even when amitrole was applied at rates as high as ten times label recommendation. There are no grounds for suspecting that residues do occur but from the legal point of view it was argued that there was no evidence to prove that an odd molecule or a trace of a conjugated derivative could not occur. On the basis of this and similar legal opinion the U.S. authorities decided that use on agricultural land should not be allowed.

There is still a great argument among leading cancer toxicologists as to whether amitrole does induce cancer. There is no denying that long term feeding of high levels of amitrole does induce goitre (thyroid hyperactivity) in experimental animals. If the feeding is continued long enough the general biochemical imbalance due to the hyperthyroidism appears to give rise to tumors in the liver. When the feeding of amitrole was stopped after 1 year the thyroids of those animals receiving 500 ppm quickly returned to normal and no hepatomas developed. The risk to consumers therefore seems hardly even a theoretical possibility.

Studies have been made to determine whether dermal or inhalation exposure to amitrole over long periods could produce an effect on the thyroid. No such effect could be produced.

There has been publicity in Sweden originated by the Swedish Civil Servants' Union who contended that the death of six railway workers since 1966 from various forms of cancer was directly attributable to their exposure to herbicides, including amitrole. The Toxicological Institute responsible for Agricultural Toxicology in Sweden pointed out that three of the cases were due to lung cancer in middle-aged men who were moderately heavy smokers. Three malignancies in five years in 420 exposed workers is below the Swedish national average for lung cancer. This has nonetheless not prevented a ban on the use of phenoxy and amitrole herbicides in Sweden.

Norris has assembled useful information about the fate of amitrole when used for brush control. There are many other reports that indicate amitrole is rapidly degraded in soil and in plant litter.

On the present evidence there appears to be no justification for restricting the use of amitrole for use on industrial sites, total vegetation control, spot spraying or for weeding perennial horticultural crops. The possibility of there being any residue in water from irrigation channels weeded with amitrole has been carefully examined and there is no indication that residues can or do occur. A limit, at or about the limit of determination is being recommended in Australia.

7. The True Facts, Please

The pesticide industry is based on technology. The technologist has, through error, thought that public relations were relations with the users of his products. The pesticide industry has not realized that public relations are just that, relations with the general public. The result is a gigantic credibility gap with the public.

The average consumer believes that food comes from the supermarket. The farmer is nothing more than a subsidized, far-off person who requires tax money to live. Some conservationists are concerned that pesticides are the prime cause of poor fishing, poor hunting, poor bird watching, or that pesticides are the only cause of endangerment to fish and wildlife. These conclusions are easy to draw because of DDT residues in the fish in Lake Michigan, or the delayed reproductivity or thin-shelled eggs of many birds. These are facts that have been highly publicized. Pesticides versus fish and wildlife is a problem - there is no question.

But let's look at some benefits of pesticides:-

- . The U.S. Bureau of National Affairs reports that U.S. food production would fall 25 to 30% without pesticides.
- . A reduction in food production of this magnitude means that about one third more land would have to be utilized. The availability of this land is in doubt. Of course, its use would involve destroying the habitat of wildlife.
- . Food costs would rise 50 to 100%. Currently, food costs 26.5% of our income. It would cost 53% of our income without pesticides.
- . Farm prices are lower by 9% than they were 20 years ago.

In conclusion, pesticides aren't all right; neither are they all wrong. Careful use of pesticides will materially benefit man. We want maximum pest control with minimum environmental contamination. Prohibition is not the answer. Regulation, education, technology, and reason are the solution.

8. Conclusion

In Australia, just as on a world wide basis pesticides can contribute substantially in the struggle for increased food production. The socio-economic benefits from their use have been clearly demonstrated but they need to be publicised in order that the average citizen can appreciate the benefit to her and him.

Pesticides like any tool can injure the user and the by-stander if misused. We need continuing effort to educate both users and by-standers so they can proceed with an adequate knowledge of what they are doing.

The world needs sanity, not emotional crusades, as it faces problems of malnutrition and disease.

The local community need and expect responsible actions and re-assurance. Fear-full people are more prone to accident and psychosomatic reaction than are those who can proceed with confidence.

I ask all those concerned with the development, distribution, regulation and use of pesticides to provide the grounds for that confidence. I beg those professional critics, activists and journalists who have assisted in spreading the hysteria to look at the facts and to search their conscience before doing the community further dis-service.

Table 1 - Types of Drugs and Other Chemicals That Have Been Shown to be Teratogenic in One or More Species of Laboratory Mammal

- Salicylates (e.g. aspirin, oil of wintergreen)
- Certain Alkaloids (e.g. caffeine, nicotine, colchicine)
- Tranquilizers (e.g. meprobamate, chlorpromazine, reserpine)
- Antihistamines (e.g. buclizine, meclizine, cyclizine)
- Antibiotics (e.g. chloramphenicol, streptomycin, penicillin)
- Hypoglycemics (e.g. carbutamide, tolbutamide)
- Corticoids (e.g. triamcinolone, cortisone)
- Alkylating agents (e.g. busulfan, chlorambucil, cyclophosphamide, TEM)
- Antimalarials (e.g. chloroquine, quinacrine, pyrimethamine)
- Anesthetics (e.g. halothane, urethan, nitrous oxide, pentobarbital)
- Antimetabolites (e.g. folic acid, purine and pyrimidine analogues)
- Solvents (e.g. benzene, dimethylsulfoxide, propylene glycol)
- Pesticides (e.g. 2,4,5-T, carbaryl, captan, folpet)
- Industrial effluents (e.g. some compounds of Hg, Pb, As, Li, Cd)
- Miscellaneous (e.g. trypan blue, Tryparanol, Diamox, etc.)

HUMAN HEALTH PROBLEMS ASSOCIATED WITH THE USE OF PESTICIDES

by

MR. R.C. McCARTHY

Senior Pharmaceutical Inspector

Department of Public Health

The number of pesticides, insecticides, weedkillers, fungicides, growth regulators marketed today is almost innumerable. Each has its particular use. Only by careful attention to the nature, purpose and method of application as a spray or a dust will they be effective and economic.

Handled with common sense and with normal attention to the detailed instructions and safety precautions set out on the label, pesticides present only a few hazards. Never-the-less care must be exercised at all times, in storage, transport, and the handling and using of all pesticides and herbicides to minimise risks and dangers to human health. Firstly consider the possible poisoning of the operator. It is important to realise that the compounds may be absorbed and so cause poisoning by several ways, skin absorption, ingestion by mouth and inhalation with lung absorption. This results from an acute toxic dose or cumulative repeated small doses, the effects of which may be unnoticed or slow in developing. The hazards - i.e. the danger of poisoning varies with the formulation or type of product - solution, emulsion, powder, gas and by the method of application - spray, dust, gas, vapours or included in paint.

Toxicity of the substances are relative to their physical and chemical properties, volatility, solubility and stability; rate of decomposition. Thus high volatility presents an inhalation problem; e.g. carbon tetrachloride, methyl bromide. High solubility presents a skin absorption problem; e.g. nicotine, the organo phosphates. Stability or degradability presents problems of persistence and the likelihood of cumulative poisoning such as with DDT, mercury or lead. Except with gaseous fumigants, skin absorption is the most likely route of occupational poisoning; the danger to the operator, be he a council employee or primary producer is greatest through the handling of the concentrates, which are more acutely hazardous than the dilute substances ready for use. These people are probably the least appreciative of the problem their attitude being that of the old idea that the skin is impervious. This is not to say that the dilute preparations are safe; they present hazards relative to cumulative effects which are slower and irreversible due to prolonged or repeated

exposures. An example is the cumulative effects of organo-phosphate and mercury substances. It is obviously impractical to deal with the precautions required for particular substances, so I want to deal with general principles which apply to the use of all pesticides.

There are a number of factors to be always considered, safety of the operator, other workmen, and the public. Then there are the risks to property, particularly to growing crops where considerable economic loss may be incurred due to the hazards of drift. So the first steps in a pesticide operation are:-

- (1) Read the directions on the label, particularly the safety directions.
- (2) Mix or prepare the preparation out of doors and standing up. Do not squat over the concentrate or the diluting container.
- (3) Warn residents likely to be affected and it may be necessary to display notices to ensure that windows are closed, children are under supervision and pets are out of the way.
- (4) No smoking or eating by the operator at work.
- (5) Adequate and suitable protective clothing for the operators, and each day a change of clothing, overalls, rubber boots, gloves, goggles and nose mask.

Application

1. Do not work alone, work upwind and watch wind.
2. Avoid applying near water supplies.
3. If spilled, wash off, remove contaminated clothing, wash affected parts of body.
4. Wash before eating or smoking.

Completion of Operation

1. Proper storage, closed containers, labels.
2. Dispose of empty containers.
3. Wash equipment.
4. Hose waterproof clothing.

1. Accidental Poisoning

It is not practical to give the signs and symptoms of

poisoning for each and every substance. Later I will describe the characteristic symptoms of organo phosphate poisoning. Generally poisoning symptoms are nausea, vomiting, weakness, headache and the victim feels ill. The important thing is, therefore, to know the name of the preparation and the active ingredients in order that the doctor will know what action to take.

A poison information service is available to give prompt advice and information to doctors and the general public on the correct emergency treatment to administer in the case of accidental poisoning. This is available through all major hospitals with the principal centre at the Adelaide Children's Hospital. If you suspect chemical poisoning ring the 'poison information service' and give the name of the product, the active ingredients, and state the symptoms and prompt advice will be given. The hospitals have a register of all agricultural chemicals used in South Australia, and so are able to offer a comprehensive service.

It is not compulsory to report cases of accidental poisoning so there are no detailed records, but statistics based on those cases reported or treated in South Australian hospitals indicate that the most easily available poisonous substances account for most cases of accidental poisoning. The largest number of victims are children. During 1972 out of 95 cases of poisoning by pesticides, malathion accounted for 13, ratkiller 4, and snail killer 3. In the case of adults there is no differentiation between suicide and accident and out of 18 cases there were 5 organo phosphate cases, 4 lead arsenate, and 2 cases of Tryquat poisoning reported in 1972. From telephone enquiries there were also a considerable number of mild cases not requiring hospital treatment.

Consider the poisonous actions of the so-called anti-cholinesterase poisons: the organo phosphates and carbamates.

When an impulse is sent along a nerve it releases acetylcholine at the nerve ending, the acetylcholine acts on the effector cells e.g. in the muscles and the characteristic response takes place. When the nerve impulse stops, the enzyme cholinesterase neutralises by hydrolysis the acetylcholine and hence no further action on the effector cell, the characteristic response then stops.

The anticholinesterase poisons, as the name implies prevents this neutralising or cancelling effect of cholinesterase by chemical combination with cholinesterase and phosphorylation and so the effector cell continues to respond to the continuing stimulus produced by the non-neutralised actylcholine resulting in tremors, muscular fibrillation, weakness, blurred vision, tightness in the chest.

If there is the suspicion of organophosphate poisoning then it probably is if:-

- (1) The history of exposure was within six hours and the symptoms are as described above.

It probably is not if:-

- (1) The history of exposure is more than twelve hours.
- (2) There is fever.
- (3) The symptoms persists for more than twenty-four to forty-eight hours.

With organo. phosphate poisoning the onset is abrupt, the course is short and the chemical manifestations are typical.

2. Hazards To The Health Of The Consumer

That is to say the person who eats an agricultural product that may have been exposed to or treated with a pesticide. This is probably the most discussed area and about which many misconceptions arise.

A manufacturer must seek clearance and registration of a pesticide and the thoroughness of the screening process ensures that pesticides are not released for use without due care and consideration. The clearance is for proper use and the improper use of any substance is almost impossible to control, the restrictions would be too onerous and effective pest control seriously impaired.

2.1 First of all a few definitions

Pesticide - or as we know the agricultural chemical, controlling, destroying or preventing growth of insects, plants, or animals.

Residue - on the food and includes decomposition products, food or anything used as or entering into human food; grain, eggs, meat, fruit and vegetables.

Tolerance - is the maximum amount permitted on food, these are prescribed in the Food and Drugs Regulations of South Australia, recently promulgated in a new list by the National Health and Medical Research Council based on W.H.O. standards.

2.2 From the human safety angle

The acute toxicity of the substance will generally determine the poisons classification, this is the hazard of exposure in one way or another to a massive dose. Generally an oral rating, but consideration also given to inhalation and dermal toxicity. It is found in general that oral toxicity levels parallels the dermal level and it is only in odd instances where the dermal level is greater than the oral. In the case of sub-acute toxicity there is generally a 90 day feeding trial and from this the 'no-effect' level can be determined and also the maximum daily dose which does not produce an effect. The no-effect level in the most sensitive species of laboratory animals is then used to calculate an acceptable daily intake for man. A rule of thumb factor of 1/100 th. is regarded as acceptable for man. In some cases perhaps because of economics a factor of 1/10 th., may be used. Less than 1/10 th., factor is currently in use for fish, a level of 0.5 ppm, due to the economic circumstances in countries where fish is not a staple diet and this is probably not irreversible. Then having arrived at an acceptable daily intake for man, all sources of the pesticide in the diet will be considered and levels fixed accordingly. Good agricultural practice is also considered and if it is found that by such good practice effective pest control can be achieved with a residue far less than would be the case based on the acceptable daily intake, then obviously the residue level will be fixed at the lower level of good agricultural practice.

Another factor that must also be considered is the agricultural use; is the pesticide in fact applied to a food crop, if not the risk is to the operator only. If the pesticide decomposes then contamination of the water supply is unlikely, so perhaps there is considerable danger to the operator but virtually none to the general public.

3. Application for Clearance - Combined Protocol

The following information is required:-

3.1 Identity

- 3.1.1 Name and address of applicant.
- 3.1.2 Name and address of manufacturer (if other than applicant).
- 3.1.3 Trade name of product (full name which will be registered).
- 3.1.4 Active constituent(s).

- 3.1.4.1 Common or generic name(s) of active constituent(s).
Synonyms, other proprietary names and code numbers.
- 3.1.4.2 Chemical name(s).
- 3.1.4.3 Empirical and structural formulae.
- 3.1.4.4 Relevant chemical and physical properties.
- 3.1.4.5 Analytical procedures for formulated material.
- 3.1.4.6 Purity of technical material. Give chemical structure and approximate percentages of compounds present as impurities. Describe tests for potency, purity and safety in manufacture and storage, when applicable.
- 3.1.5 Formulation of the proposed product.
- 3.1.6 Stability and shelf life of formulated material.
- 3.1.7 Current Uses. A brief but comprehensive description of present uses of the active constituent(s) in the product.
- 3.1.8 Proposed use:
 - 3.1.8.1 Justification for proposed use.
 - 3.1.8.2 Claims to be made.
 - 3.1.8.3 Draft label giving full directions for use, limitations, recommended withholding period(s), special safety precautions, etc.
 - 3.1.8.4 Proposed packaging. Give details of size, shape, construction and lining of proposed containers.

3.2 Efficacy and Safety

- 3.2.1 Efficacy. Evidence including that from Australian trials, to show that the material will perform as claimed, when used according to the label directions.
- 3.2.2 Safety (other than to humans). Evidence to show that no undue hazard will arise for:-
 - 3.2.2.1 those crops or plants being treated
 - 3.2.2.2 non-target crops, plants, insects and domestic animals and wildlife
 - 3.2.2.3 the environment

3.3 Toxicology

- 3.3.1 Acute toxicity.

- 3.1.1.1 Acute oral LD50 in at least two unrelated species, one of which should be a non-rodent.
- 3.3.1.2 Local and systemic toxicity by typical application and by inhalation.
- 3.3.2 Sub-acute toxicity studies (short term toxicity studies).
- 3.3.3 Chronic toxicity studies (long term toxicity studies).
- 3.3.4 Any human toxicology data.
- 3.3.5 Metabolism, absorption, storage, biochemical change and elimination.
- 3.3.6.1 Level causing no toxicological effect in the most sensitive species tested.
- 3.3.6.2 Estimate of probable acceptable daily intake for man.
- 3.3.6.3 National tolerances. Australian, overseas or Codex Alimentarius.
- 3.3.6.4 Any recommendations the applicant may wish to make concerning proposed tolerances or withholding periods.

3.4 Residues

- 3.4.1 Residues resulting from supervised trials both overseas and Australian.
- 3.4.2 Fate of residues including metabolites.
- 3.4.3 Analytical procedure(s) for residue determination.

3.5 General

- 3.5.1 Registration status - Australian and overseas.
- 3.5.2 Evidence of approval or rejection by any other statutory body or authority either in Australia or overseas.
- 3.5.3 States in which application for registration will be made if clearance is approved.
- 3.5.2 Bibliography.

4. Selected Explanatory Notes

4.1 Safety (Other than human safety)

4.1.1 Non-target crops, plants, insects, domestic animals and wildlife.

Where it might reasonably be expected that the use of a chemical could give rise to hazards to non-target species including plants, insects, birds, domestic animals, fish, soil and aquatic biota, wildlife etc., data from tests indicating the toxicity of the chemical to such species should be presented.

The effect of repeat treatments and carry-over of soil residues to subsequent crops should be fully considered. In the case of broad spectrum insecticides, possible adverse effects on beneficial species should be considered. Safety to livestock and other domestic animals should be considered in light of the toxicity of the chemical itself and the proposed method of application.

Instructions should be presented to indicate correct procedures for safe disposal of unwanted product and used containers.

4.1.2 The environment.

Where the use of a chemical could possibly be considered to lead to unacceptable contamination of the environment, full details should be present to demonstrate the acceptability of the proposed use pattern of the chemical.

Special consideration should be given to chemicals and use patterns which fall into the following categories:-

- 4.1.2.1 Highly persistent chemicals
- 4.1.2.2 volatile materials (2,4-D esters)
- 4.1.2.3 materials applied in proximity to waterways
- 4.1.2.4 materials applied from the air or by other methods which might permit appreciable drift from the target.

4.2 Acute Toxicity

The degree of hazard presented by pesticides and similar chemicals depends on many complex factors. Although no single factor is completely reliable, the acute toxicity of a chemical probably gives the most useful rapid indication of the potential hazards to human users, and

probably also to domestic animals. Poison scheduling is therefore based largely, but not entirely on acute oral, dermal and inhalation toxicities. In most instances these fundamental parameters of toxicity enable reasonably accurate prediction of the extent to which a chemical will be hazardous for the ignorant, the innocent and the unwary.

Reports of toxicity tests should be sufficiently detailed to allow comparison of results with those reported from independent laboratories and to enable independent evaluation including statistical examination.

4.3 Sub-Acute Toxicity

Sub-acute toxicity determinations may be performed for several purposes and will be included in the majority of submissions. For example:-

- 4.3.1 It is generally accepted that a tolerance for negligible residues (vide infra) may be recommended on the basis of 90 day, sub-acute feeding trials in rats and dogs.
- 4.3.2 A provisional tolerance for finite residues may sometimes be recommended on the basis of 90 day sub-acute feeding trials in two species, provided that 2 year, chronic feeding studies have been commenced, or are about to be commenced.
- 4.3.3 Sub-acute studies are essential as preliminary range finding studies prior to the commencement of chronic feeding trials.

Sub-acute studies should demonstrate a "no effect" level. It is usual to include a control group and three or more dosage levels, at least one of which should be non-toxic. The test material should be given daily by the oral route, either in the feed or by stomach tube, for the duration of the trial.

4.4 Long Term Toxicity Studies

4.4.1 Chronic feeding trials.

These normally consist of daily oral administration of the test compound for two years to two species, usually the rat and dog. It is necessary that a "no effect" level be clearly demonstrated and stated in the summary. Statements such as "the no effect level lies between X and Y mg/kg/day" are not acceptable.

4.5 Human Toxicological Data

These may take any of the following forms:-

- 4.5.1 Long term study of industrial exposure, either in the factory or the field.
- 4.5.2 Study of accidental poisoning and suicide attempts.
- 4.5.3 Studies with volunteers.

Human data are particularly valuable since they help to cover the possibility that the human is more sensitive than any of the laboratory animals used in trials. In certain cases, provision of adequate human data may enable reduction of the safety factor from hundred-fold to ten-fold.

4.6 "No Effect" Level

When the chemical has been administered in the feed of the test animals, the highest concentration which produces no toxic effect in the test species is termed the "no effect" level and is expressed in ppm.

4.7 Acceptable Daily Intake for Man (mg/kg/day)

The acceptable daily intake of a chemical is the daily intake which, during an entire lifetime, appears to be without appreciable risk on the basis of all the known facts at the time. It is expressed in milligrams of the chemical per kilogram of body weight (mg/kg).

The acceptable daily intake for man is usually calculated as one-hundredth of the "no effect" level in the most sensitive species of laboratory animal tested. In certain exceptional circumstances it may be calculated as one-tenth of the lowest "no effect" level determined.

Tolerances are calculated so that the acceptable daily intake will not be exceeded by the sum of the residues in the human diet from all possible sources.

4.8 Residue Data

Applicants are required to produce results of field trails to show the level of residues of the original compound(s) and/or metabolites which occur in animal tissues or edible crops when the pesticide is applied at the maximum level described in the label directions.

5. The Poison Regulations

These apply to the sale of poisons, and have not so far applied to possession for use. A new power introduced last season means that it is now possible to look at the uses that these poisons are put to. There are, however, problems with the surveillance of users, it is possible to deal with contractors using these poisonous substances but not the general public. The basis of the regulations is for the protection of the public to prevent accidental poisoning due to carelessness in storage and use. Regulations cannot prevent suicide or murder by poisonous substances which when used properly have a role to play in agriculture as pesticides or useful chemicals in other industries. The safeguards to the user are the labels and the appropriate safety directions which are listed on them, the type of container, and the fact that the sale of agricultural chemicals listed under Schedule 7 are restricted to specially licensed dealers only.

The control system is based on the use and selling outlets, the Poison Schedules being numerically listed from 1 to 8, and the numbering of the schedule has no bearing on the relative toxicity of a substance. Those chemicals contained in any one schedule is merely a group to which varying restrictions on the use and sale apply, and it is not a toxicity rating. For example the fact that a chemical is designated S.1 does not indicate that it is more toxic than a chemical listed under S.7.

A list of the Poison Schedules is described below with examples in each grouping:-

- S.1 - Substances extremely dangerous to human life -
Atropine.
- S.2 - Substances dangerous to human life if misused or carelessly handled - medicinals with therapeutic doses of poisons - Codeine up to 1%.
- S.3 - Therapeutic substances sufficiently dangerous to human life to warrant supervised sales by pharmacists - Antihistamines.
- S.4 - Therapeutic substances which in public interest should be restricted to prescription and new substances as yet insufficiently evaluated - Antibiotics, sedatives, sulphonamides.
- S.5 - Hazardous substances, readily available to the public but which require caution in handling, storage and use - Petroleum solvents.

- S.6 - Poisonous substances, to be readily available to the public for domestic, agricultural etc., or industrial purposes - Pesticides, industrial chemicals, acids, alkalies.
- S.7 - Substances of exceptional danger which require special precautions in manufacture and use.

Special restrictions may apply

Agricultural - highly toxic O.P.'s,
arsenical weed killer - Chloropicrin

Therapeutic - Ovulatory stimulants

- S.8 - Narcotic Drugs.

The S.7 agriculturals are restricted to specially licensed dealers so as to be available to primary producers; they may not be sold by the unlicensed hardware store which is restricted to S.6.

Stock medicines based on S.4 drugs e.g. Antibiotics which are registered under the Stock Medicines Act are to be S.6 - e.g. Penicillin for intramammary use and available from ordinary vendors including milk factories.

THE COMPLEXITIES OF PEST CONTROL AND WILDLIFE CONSERVATION

by

DR. B. SHEARER

Dept. of Environment and Conservation

I do not intend to present a list of pesticides and the associated problems that they have created, but will discuss some matters which will reveal the problems associated with the use of pesticides in complex natural systems.

1. First of all What is a Pest?

In the past pests have been defined rather glibly and generally as they relate to agriculture. However, agriculture is not the only land use system and pest definitions must be updated. The mangrove (*Avicenia marina*) is considered by many people to be a pest and so should be removed by dumping rubbish and filling, or by clearing. However, from research into the ecology of our marine fauna the mangroves play a vital role in the life cycle of the marine fauna. Thus mangroves should be looked more upon as a "marine pasture" plant for fish production, in much the same way that Bluebush (*Kochia sedifolia*) is considered a pasture plant in agricultural production.

The dingo (*Canis antarticus*) is considered to be a pest in some localities and they are controlled without due consideration of their natural role in this country. Such a role was revealed to a friend of mine who was involved in studying a new poison to control the dingo. This work was being undertaken in the western areas of New South Wales. On his first visit at the time of the trial baiting its success was obvious with large numbers of dead dingoes and foxes to be seen and only a few live ones to be encountered. Over a period of years the area was observed and the poison was found to be highly effective, so that during a visit some two years after the initial poisoning, no live dingoes were observed, but there was a plague of kangaroos and rabbits. The dingo is no doubt a predator of the kangaroo and may be, with the fox, a predator of the rabbit. Thus was this plague a case of a self-inflicted wound?

Consequently, before a proposed pest is defined as an organism to be controlled, the total ecology of that organism and its associations must be understood. A pest to one land-use system, may be god-sent in another, thus rye-grass may be a pest

to people who are allergic to it, but it may be a blessing as a pasture plant. Thus should the loliums be declared pasture plants or noxious weeds? Following this still further, who is going to declare what is a pest or not?

I believe that only a corporate body which represents the view point of all sections of land use systems can really do this.

2. What Pesticide will be Used?

Assuming then that an organism is declared a pest, then who decides what product should be used to control the pest? This can be important, but does require specialist chemists to keep up to date with the rapidly changing information available. This problem was revealed to me during my research work in the U.S.A. which involved the study of the then known chlorinated hydrocarbons, DDT, Lindane and Dieldrin.

Some 20 years ago when the residual quantity of DDT in plants or in cells or in water was determined, the results were generally zero because the techniques used to determine the concentration could not measure low levels. With the development of Gas Chromatography, it was possible to measure quantities of organic compounds down to nanograms (10^{-9} gram). Following this, DDT was found to occur in almost anything and everything. This information was used to crucify DDT and so a great deal of work was undertaken into residual DDT. Then in Canada, I believe, at Guelph, some soils which had been sampled, sealed and stored before DDT was discovered were used as controls in some DDT work. Unfortunately or fortunately, they were found to contain some of the highest levels of DDT. After eliminating the possibility of contamination, it was proposed and later proved that some other compound very similar to DDT was naturally produced in the soil and was measured as part of the DDT content. Later work has raised this number to 9 compounds, some of which are common bi-products of the tyre industry and which are pumped away as waste products. Thus the question now arises as to how much of the old evidence on DDT is meaningful?

Thus a chemist who is completely aware of the latest scientific information, should be consulted.

In addition the possible or actual side effects of a pesticide on the environment, should be used in deciding what pesticide should be used. I believe, therefore, that one aim of my talk should be to ensure that you all become aware of the principles of inter-acting systems that occur in our environment.

3. Some Side Effects we can Find in Pesticide Usage?

Some of you will be familiar with the program for control of South African Daisy (*Senecio pterophorus*), in reserves under the control of the Minister of Environment and Conservation.

When this program was first proposed for Cleland Conservation Park, the Department of Agriculture proposed that three techniques be used to control it, hand-pulling, hand-spraying with Weedazol and aerial spraying with Weedazol. Our own ideas on control, which unfortunately had no direct evidence, but a considerable amount of circumstantial evidence, to support them, was to regenerate the native vegetation of the area to a point where South African Daisy would be competed out of the area. This would then give rise to a long-term control. Naturally, checks could occur in our regeneration program, due to especially to fire, this could be handled in the total regeneration program.

Consequently we objected to the spraying on various grounds, but mainly from the point of view of possible side effects, of the spray on native vegetation and fauna. The only "evidence" that we could present to support this objection came from an earlier spraying some years before which gave rise to chlorotic leaves in eucalypts and acacias. But these trees, did after about 3 years recover.

However, the Department of Agricultural Representatives argued that there was sufficient evidence to indicate that this side effect was transient and that as the active life of the chemical was about six weeks there would not be any long-term effects.

Thus as we could not provide any proof to the contrary, because of the lack of information available, we were obliged to agree to the spraying.

I personally witnessed the aerial spraying by helicopter and must comment how efficient this technique was. It gave, what I thought was a very well controlled application.

However, the side effects of the weedicide were most discouraging and substantiated our earlier fears for there were three main side effects.

- 3.1 A large number of native plants (more than was expected) became chlorotic.
- 3.2 Some seedling and small native plants, and especially those of *Acacia pycnantha*, were killed.
- 3.3 The weedicide was not inactivated either in the soil or in the plant, for following heavy rains some three months after the spraying, severe chlorosis occurred in many native plants.

The frightening consequence of (2) above, was that the primary colonizer which would be used to regenerate the native scrub, i.e.

Acacia pycnantha, was killed as a seedling and severely affected by the spray as a more mature tree. So the main native competitor that, we believe, would control daisy as well as initiating the regeneration of the area, was also eliminated.

Thus pesticides are not necessarily the only techniques available to us in controlling pests in native vegetation and people experienced in the ecology of native wildlife must be involved in pest control in our reserves.

No doubt many other aspects of pesticide use and environmental problems could be discussed in relation to effects on man, e.g. pollution of underground surface waters, pollution of the aerial environment and pollution of foodstuffs, and direct or indirect effects on native wildlife.

However, I hope that, through the few examples I have given, you will now realise that many interactions between pesticides and native wildlife can occur, that biologists in the wildlife field do not have a great deal of information available to them (and yet they can still foresee dangers as a result of experience) and that interdisciplinary or interdepartmental working groups must be involved in working on our environmental problems.

PROCEDURE FOR CLEARANCE AND REGISTRATION OF NEW

AGRICULTURAL CHEMICALS

by

MR. B.D. ROBINSON

Technical Adviser

A new chemical can be defined as one that has not been previously registered in any State in the Australian Commonwealth. In order to appreciate the registration procedure in its proper perspective, it seems appropriate to trace the development of a new pesticide from synthesis to initial marketing.

The first stage in this "production line" is the synthesis of thousands of new chemicals and their testing for biological activity. This fairly simple process is called SCREENING, and this stage involves very simple toxicological tests on the chemical being synthesised. From these screening tests the biologically active ones are noted and appropriate related chemicals are synthesised and screened so that the most potent members of a group of chemicals are selected for patenting and field investigation. At this stage more toxicological tests and the selection of the key compounds, which will probably be marketed, will be given detailed toxicological tests and possibly given long term and short term feeding trials.

The long term and short term feeding trials etc. are started fairly early in the history of the pesticide in order that ample toxicological data is available when registration is applied for. Long term feeding studies could go up to two years and thus the decision on these studies must be made as early in the history of the chemical as is economically prudent.

The next main stage will be to determine the major fields of usage for the pesticide and to conduct concurrently with trials on efficacy the appropriate research on residues and/or breakdown products of the pesticide being investigated. Once this residue data has been determined, and the appropriate long term feeding studies have been conducted, plus other relevant toxicological tests such as inhalation studies, dermal toxicity studies and appropriate toxicological studies on wildlife as and where considered necessary, then the company will probably consider applying for registration at a federal level.

If the toxicological data considered appropriate by the National Health and Medical Research Council (N.H. & M.R.C.), then they will approve of the use of the chemical and agree as to the appropriate poison schedule, as well as the tolerance and the withholding period necessary to ensure proper use of the chemical.

When N.H. & M.R.C. arrive at these decisions, they take into account what is called the "use pattern" of the pesticide in relation to the crop or situation in which it is being used. The pattern obviously must embody what is called good Agricultural practice, this also must embody what is called appropriate rate of use. Thus in the determining of all these factors we must establish that the chemical is effective at the rate required and that the residue at the rate used will not harm man or produce. The good Agricultural practice also must take into account the use of the material and its possible effects on the environment.

Once a company submits toxicological data through N.H. & M.R.C. a summary of the toxicological data plus all data on efficacy formulation etc., is presented to the Pesticides Co-ordinator, whom you have already met, and copies are distributed to members of the Technical Committee on Agricultural Chemicals (T.C.A.C.). The copies of this data are then studied by the various members who report back as to whether they consider that this chemical should be given a clearance for use in Australia or not. Once having passed this hurdle the chemical is then considered for registration by the various state authorities, who ensure that labels as submitted not only comply with State requirements, but are also acceptable within the clearance issued by T.C.A.C.

This is only a very brief wordsketch of the lengthy, complicated production line in the registration of a new pesticide. Very few if any new pesticides pass through all these hurdles without questions or without the various authorities requiring more data than has been presented.

It would take a company approximately 2 to 4 years to take a chemical from the patenting stage to the registration and initial selling stage. Evaluation of efficacy and the appropriate toxicological work involves the company in enormous expense over this period and all this money has to be spent before registration and before any return on the money invested can be obtained. Hence whilst the cost of making the pesticide may or may not be great, the cost of the technical input into the manufacture, formulation, labelling and registration of a pesticide is enormous, and thus quite often the actual cost of the chemical involved, and the price of the pesticide appears to be out of all proportion. However, this can easily be appreciated if one knows that millions of dollars can be spent on a pesticide prior to registration.

It is amazing how the public appear to have the impression that chemical companies are able to thrust new pesticides on to the market without being subject to any degree of regulation or control. I hope that this will give you some idea of the effort which is placed into ensuring that only environmentally suitable, toxicologically safe and Agriculturally effective pesticides are placed on the market. The public are also not aware that the process of competition in the Agricultural chemical industry ensures that better, safer and more selective pesticides are developed.

SECTION II

PLANT PROTECTION WITHOUT HERBICIDES

AGRONOMY BRANCH MINI CONFERENCE

FARM HYGIENE

The Place of Cultural and Rotational Factors in Plant Protection

by

MR. G.D. WEBBER

Acting Senior Agricultural Adviser

1. Introduction

Sound cultural and rotational practices which build and maintain soil fertility resulting in the growth of high producing crops and pastures are basic to our agricultural system.

A significant part of plant protection from weeds, pests and diseases is brought about by managing and adjusting the cultural and rotational aspects of our agricultural production programme.

The use of chemicals in such a production system should be an aid, and not an end in itself. Some examples of adjustment of normal rotational and cultural practices to reduce losses from weed competition, disease attack and insect pest infestations.

2. Weed Control

The answer to most weed control problems is not a one shot control measure by itself, it involves practices to reduce or control weed competition, and the introduction of more productive species to effect long term control.

In cropping areas soil preparation and annual weed control go hand in hand. Normally the most economic weed control system is one which is built into the normal cultural, grazing and rotational programme.

Developments in tillage implements have enabled larger areas to be covered in less time, this allows better timing of cultivation treatments for annual weed control.

Some important specific examples of cultural and rotational factors in weed control are:-

- 2.1 Soursoy - Time cultivations and cropping can be carried out to reduce bulb numbers to a level where competitive pastures can be sown to maintain control. This has been

the main control programme in South Australia with chemicals in some cases an aid in the programme.

- 2.2 A number of weeds can be controlled most effectively by competition from vigorous pasture plants e.g. Onion Weed and Horehound. Time cultivation programmes followed by the establishment of Lucerne stands, well managed with frequent renovation has seen long term control achieved.
- 2.3 Much of the problem with annual grass weeds in cereal crops e.g. Wimmera Rye grass and Bromes can be reduced by topping, haycutting or hard grazing to reduce seed set in pasture years prior to cropping.
- 2.4 In the higher rainfall pasture areas weed control and increases in production capacity of paddocks can be achieved by establishing perennial grass such as phalaris - e.g. sorrel, capeweed, geranium, etc.

3. Plant Diseases

The most regularly damaging diseases of cereal crops in South Australia are the cereal root diseases, cereal eelworm, Hay-die and Rhizoctonia. The losses from these diseases can be large.

The major part of the answer to these problems is cropping and rotational management with such factors as soil fertility, time of sowing, type of crops, frequency of cropping, fallowing, etc. being the main factors influencing their effects.

It would seem fair comment to say that the build up in diseases such as eelworm would indicate insufficient consideration being given to cultural treatments in growing crops in regions where the problem exists.

3.1 Cereal eelworm

There are two main factors in long term control:-

- o increasing soil fertility
- o preventing a buildup in nematode populations

In most cases this can be achieved with good legume pastures and a suitable crop rotation.

Legumes have a two-fold effect in that they not only prevent a build-up of eelworms, but also improve fertility, enabling a more vigorous crop growth that is better able to withstand the disease.

-40-

Some of the important rotational factors to be considered are:-

- . Peas, Lucerne, Lupins and Lucerne are non-host crops.
 - . In areas of eelworm infestation, consecutive cropping must be avoided, as a large build-up of the disease can take place in only one year.
 - . In clean areas that have not been troubled by eelworm, care should be taken to thoroughly clean implements or vehicles which have come from an infested paddock.
- Much has still to be learnt about the incidence of cereal root eelworm under Australian conditions. A more critical evaluation of rotations and other cultural treatments is needed before more effective means of controlling the disease are clarified.

3.2 Takeall

As there are no resistant wheat varieties available and no chemical means of controlling the disease, control methods should aim at:-

- . Producing vigorous crops.
- . Avoiding a buildup of infectious material.

This can best be done by growing legumes and maintaining them with adequate superphosphate applications, and also by discouraging natural grass hosts, like silver grass, spear grass, brome grass and especially barley grass. Rotations should be planned bearing these points in mind.

Where trouble is experienced with "hay-die", resistant crops like oats, lucerne, peas and linseed could be used in rotations as clearing crops in areas suited to their cultivation.

Other factors that can have some effect in controlling hay-die are:-

- . Long fallow
- . Well compacted seedbed conditions
- . Avoiding deep sowing
- . Reducing grass residues
- . Burning stubbles

3.3 Rhizoctonia

The problem of rhizoctonia is more complex, because of its much wider host range, and hence rotational factors are not as significant in reducing the extent of the disease. However, such factors as, high soil fertility, long fallow, shallower seedings, well prepared seed bed conditions, have been observed to reduce the extent of damage.

3.4 Other diseases

Leaf diseases of cereals carry over on plant debris and such factors as burial, rotations and burning will influence the amount of carry over. It is well established in the case of Black Spot diseases in field peas that more frequent cropping than every 4 to 5 years, eventually leads to a severe build up of disease problems.

4. Pests

The main insect pest problems which are significantly affected by rotational and cultural practices are the underground pests e.g. cereal curculio, Talis, Cockchafers. These pests build up under grassland farming conditions, and have increased in areas where there has been a swing away from fallowing and frequent cropping to a longer period under pasture.

In the case of cereal curculio, most infestations occur in cereals sown in May-June following a predominantly barley grass pasture at least 4 years old initially worked up with February-March rains. Fallowing old pasture land, late seeding and higher seeding rates have reduced or eliminated damage. Talis damage occurs on old pasture land initially worked within 3 weeks of seeding, with earlier workings, damage has been averted.

- 4.1 Pasture cockchafer - In the case of pasture cockchafer damage in cereals, normally the land preparation before cereals are sown is sufficient for control, because cultivations bury the surface organic matter. Without this organic matter the young larvae starve. For cultivation to be successful it must be carried out before May. On the light soils of southern Yorke Peninsula and southern Eyre Peninsula the initial cereal land preparation is carried out before May, but it is shallow, and is usually done with a combine only. This process breaks up the soil but the surface organic matter is not buried and remains within reach of the young larvae, enabling them to survive.

5. Conclusions

The above cases are some examples of where cultural and

rotational factors which can reduce damage from pests, diseases and weeds. Due consideration to the many factors involved in crop and pasture production can in many cases lead to modification of normal practices, to climate or reduce plant protection problems.

There will of course always be situations which arise where chemical control will be necessary as an aid in the control programme.

FARM HYGIENE

Farm Hygiene & Grain Pest Control

by

MR. P. BIRKS

Senior Research Officer (Entomology)

1. CHEMICALS

There are very few pesticides which can be added to grain. Already we have had to ban one - HCB - because a small proportion of farmers have misused it. Improper use of any chemical on grain is likely to bring similar action. The need to get this message over to farmers is urgent. Of 91 farms surveyed in 1972 three farms used unacceptable insecticides, viz. azinphos ethyl (1), parathion (1) and DDT. A further 3 farms misused maldison and 3 misused phostoxin. In the very near future farmers will be tempted to use all sorts of chemicals as maldison resistance becomes steadily more widespread. "Use only those pesticides recommended for grain storage and use them only in the manner prescribed" - this message must get across loud and clear as a matter of urgency.

2. HYGIENE

In recent years we have given too little attention to farm hygiene in relation to grain pest control, mainly because a bit of maldison would soon fix our problems. Now resistance is becoming very widespread in the whole of the grain trade, although not yet widespread on farms (1/49 farms). However, it is becoming common on Western Aust. and Queensland farms already. Also resistance to dichlorvos, the only other chemical we can add to grain with relative safety at present, has now been established. (The use of maldison has induced this resistance to dichlorvos). Therefore, neither farmers, millers or the export trade are going to have it so easy from now on.

3. SOURCES OF INFESTATION

It was Louis Pasteur who demonstrated that infestation of grain did not just happen by spontaneous generation - it required an innoculum of insects to set it off. In the same way the silo of feed or bags of seed require insects to invade them before they can become infested. The more insects on a farm, and the nearer they are to silos etc., or augers and bins, the easier it is for infestation to occur.

4. FARM SITUATION

What is the infestation status of our farms? Of 91 farms examined in 1972, particularly by District Advisers, on one farm no insects were found. On all of the other 90 some infestation was found. On 29% the infestations were classified as light, i.e. insects occurring singly or in 2's and 3's in the course of a prolonged search. On the remaining 70% of farms the infestations were moderate to heavy. It was quite remarkable how heavy some infestations were. The species present were:-

Granary weevil	40%	of farms
Rust red flour beetle	30%	" "
Sawtoothed grain "	29%	" "
Spider beetles (3 spp.)	30%	" "
Flat grain beetles	16%	" "
Lesser grain borer	15%	" "
Rice weevil	8%	" "

Fourteen other species were present on a smaller proportion of farms.

5. FARM SANITATION

It was not surprising to find so much infestation on farms because the level or standard of hygiene with regard spillage was so very poor.

The facilities used for storing grain were very variable, ranging from silos 40% and mouseproof barns 4%, to old houses 2% and sheds with dirt floors 2%. However, while many facilities were structurally sound, carelessness with spillage was the rule.

For all this though, the most encouraging aspect of the survey was just how far good hygiene could go towards solving the grain infestation problems. Highly elaborate buildings are not required, but meticulous attention to detail is essential. On one of the best farms it took 2 of us 2 hours to find a weevil. We hunted very hard and picked on every little detail capable of improvement - such as:-

- 5.1 Weeds and timber around wheat shed harbouring mice.
- 5.2 Scraps of bag and butt of old residues inside wheat shed harbouring mice.
- 5.3 Harvester in grain shed - not desirable.
- 5.4 Excess fowl feed in fowl yard right beside wheat shed - debeaked chickens a mistake.

- 5.5 Old feed residues in disused fowl feed bin - had been infested.
- 5.6 Butt of old sheep nuts in nearby shed - spider beetles.
- 5.7 Residues in field bin.
- 5.8 Downpipe on mouseproof barn not steep enough.
- 5.9 Timber under mouseproof barn acting as ladder for access.
- 5.10 Small spillages - handfuls under trapdoor in mouseproof barn floor - ONE WEEVIL.

All these minor points seemed insignificant until we found that one of them was harbouring infestation - any one of them may have been - and it only needs one source to be undetected to spark off a whole problem. So not only was it clear that good simple hygiene would almost entirely solve the problem, but also a very simple little oversight was sufficient to undo it all.

6. THE FUTURE

It is very clear that we have a very long way to go. On some farms storage facilities are not adequate. Over the next few years some will have to be replaced, some given a major overhaul. In the same way the problems of dealing with existing infestations and potential infestations or spillages required a major change in attitude by some 70% of farmers. The results of this survey will help. It is highly likely that legislation will be enacted and inspectors appointed to enforce a major and rapid change. There has been some progress towards establishing better detection sampling at receipt depots with a view to either penalising offenders or subjecting them to close inspectorial supervision. There is an urgent need for education of farmers by every conceivable channel to:-

- 6.1 Upgrade storage facilities.
- 6.2 Clean up existing infestations.
- 6.3 Improve standards of hygiene and thoroughness.
- 6.4 Stress the proper use of only approved and recommended chemicals.