Preface

In to-day's world there is a growing public perception that "natural" things are good and man-made things are bad. The public often speak against chemicals in food, in the environment, in the work place, at home and, particularly, in agriculture. Pesticides are not good for you!! On what basis are these claims made? Is it really better to live in a world fed from organically grown crops? Are all crop protection agents harmful to wild life, beneficial species and man? Could we feed a world of 6 billion from traditional, non-chemical, agricultural production? Is natural really healthy?

These were some of the questions the organisers sought to ask at the symposium on "Food Quality and Crop Protection Agents." To this end an audience was invited from various interested organisations to listen to presentations both for and against chemical crop protection, followed by a discussion period during which it was hoped that key issues would be debated. This volume contains the papers presented by the speakers, together with a full summary of the discussion period.

It was a pity that many of the invited audience, particularly the press, failed to attend. This meant that publicity of a very important topic was reduced and that all aspects of the topic were not addressed equally. However, presentations from HM Government, the Industry, Regulatory Authorities, Organic Farmers, Parents for Safe Food and The British Nutrition Foundation guaranteed a well rounded programme.

Nevertheless, the organisers were disappointed with the fact that the vast majority of the discussion time concentrated on one very small aspect of the subject – that of pesticide residues. We all heard that the required safety margins imposed by statute guarantee safety. We learned that 1 ppb is one second in one's lifetime and that if the same safety rules were applied to car travel at 30 mph, we would have to allow a stopping distance of 4 km. Whilst safety of our food is paramount, the maximum residue level allowable in food stuff is not the real issue. The real questions are, is it possible to feed the world without the aid of chemicals and do chemicals enhance or diminish food quality?

It is very easy from the position of an over-producing agricultural system and overfed population to apply solutions of our own problems to the very different problems of an underfed developing world. China, for example, has 25% of the world's population on 9% of its productive land. Production is such that they import 10 million tonnes of grain each year. It is estimated that productivity would fall by over 30% if crop protection chemicals were withdrawn, increasing their need for imports many fold. Who are we to tell others they must lower their quality of life still further or worse, condemn people to starve to death because we do not like chemicals?

Food quality is another important aspect of production. Is it only residues from man-made chemicals that we have to fear? What about the presence of ergot alkaloids in grain grown from untreated cereal seed? What about the carcinogenic mycotoxins produced by a wide variety of fungal contaminants of

stored food? What about the removal of toxic weeds such as *Datura stramonium* from crops? Is the removal of the ragweed, which accounts for 80% of the allergenic reactions in the USA, not a good, healthy objective? What about the natural biocidal components of crop plants, whose toxicological profiles have not been determined, that are known to increase with pathogen or pest induced stress! These are all key questions which, it was hoped, would have been debated. This was not the case. The continued debate on levels of detection reflect the industry's over-cautious attitude to the issue. Where is the argument that chemicals save lives? That, even in Europe, we have only 47 days' food reserve and even this could not have been achieved without crop protection chemicals? Chemicals for a Safer Environment, a campaign launched by a former President of SCI, is the issue. Please read the talks and the discussion contained in this monograph and then think carefully about the issues.

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LEN COPPING
TERRY GRAYSON

Introduction

PROFESSOR C. R. W. SPEDDING

Centre for Agricultural Strategy, University of Reading

There is little doubt about the need, worldwide, to protect crop plants from attack by weeds, pests, parasites and diseases. It is difficult to assess the need in quantitative terms but crop losses are generally considered to be serious.

The problems are *how* to protect them, without adverse effects on the environment, valuable fauna and flora, including soil organisms, and on people, especially during food consumption or by accidental contact.

The methods available include mechanical means, manual operations, fire, the application of "natural" or "artificial" substances, and the use of biological agents. All of these can affect the environment, fauna, flora and people, and the greater our understanding of the relationships involved the safer it will be possible to make food production, though we should not forget what a high proportion of our food is processed, however simple the procedures employed.

So many disciplines are involved that it is unlikely that specialists will have the whole answer and, in any case, scientists can only assess the evidence currently available and that is usually incomplete.

Consumers, as citizens, are entitled to their concerns, however ignorant the consumer and however inarticulate or inaccurate the expression of those concerns. Confrontation is most likely where concerns are brushed aside or not taken seriously. Trust in the authority of those who seek to reassure depends upon their independence as well as on the confidence that concerns *are* treated seriously and that, in consequence, the *questions* posed are the ones that matter.

Unfortunately, the general reluctance of industry to do this at an early stage tends to generate antagonisms and suspicion that continue even after the industry has recognised the need for change.

The same kind of attack that may bring about a willingness to change, may then get in the way of constructive debate about what changes are desirable. Polarisation is a first, and often necessary step, but it eventually has to be overcome.

In relation to the most acute issue of today's conference – the use of agrochemicals in the production of food – the need now is to listen to the other fellow and jointly work out how genuine progress can best be made.

SOCIETY OF CHEMICAL INDUSTRY SYMPOSIUM : 8 OCTOBER 1991

FOOD QUALITY AND CROP PROTECTION AGENTS

THE BRITISH GOVERNMENT'S POLICY ON PESTICIDES

SPEECH BY THE PARLIAMENTARY SECRETARY, MINISTRY OF AGRICULTURE, FISHERIES AND FOOD, DAVID MACLEAN MP

(In Mr Maclean's unavoidable absence this speech was presented on his behalf by Mr G K Bruce, Head of MAFF's Pesticides Safety Division.)

1. May I first thank the organisers for their kind invitation to open this symposium. The subject is one of great public interest and I am delighted to have this opportunity to outline our policy on pesticides and the systems we have in place to bring it into effect.

2. It is perhaps worthwhile first reminding ourselves that there is a real need for these chemicals. Concerns are frequently voiced about the dangers of pesticides. It would be surprising if they were not. These are toxic products designed to kill pests and combat diseases. We need to have the means available to us to ensure that pests are controlled and food safeguarded. The Governments' aim is to ensure safe use of pesticides to protect both the supply of food and its wholesomeness.

Government Policy: Comprehensive Controls in the UK

3. Most people are aware that there are some controls on pesticides. But few really understand how they operate or how far they go beyond simply approving chemicals. In fact, only pesticides approved by the registration authorities may be advertised, sold, supplied, stored or used in the UK, and there is

an extensive range of legislative and administrative controls over the approval, storage, marketing and individual use of pesticides.

4. Underpinning these controls is a clear Government policy directed towards the safety of humans, animals and the environment. This is why Ministers created the Food Safety Directorate within the Ministry of Agriculture, Fisheries and Food, of which Pesticides Safety Division forms a part. It is the same philosophy which was expressed in the White Paper 'This Common Inheritance' which set out the five main planks on which the present approvals system is based. These are:

- to take account of efficacy, human health and environmental factors in decision making on the use of pesticides;

- to ensure that pesticide approval procedures are fully independent of particular sectoral interests;

- to limit pesticide use to the minimum necessary for the effective control of pests compatible with the protection of health and the environment;

- to review regularly all approvals and take action if significant new information about harmful effects comes to light; and, very importantly,

- to make information supporting decisions on the use of pesticides available for public scrutiny.

Controls over Approvals

5. In the first instance, an enormous quantity of complex and highly technical information must be submitted by applicants wishing to register a new pesticide; the pile of documents

required can easily reach five feet in height. Studies covering toxicology, residues, environmental fate and behaviour, safety and efficacy, must first undergo evaluation by Departmental scientific experts.

6. The results of this evaluation are submitted to the independent Advisory Committee on Pesticides. This Committee forms the lynch pin of Government policy on pesticide approvals. It provides Ministers in the six Departments responsible for the approval of pesticides with advice on which to base decisions. The Advisory Committee is assisted in its work by its Scientific Sub-Committee and a range of expert Panels covering Medical and Toxicological issues, Application Technology, Label and Container Design and Environmental matters. Further information and advice in support of ACP recommendations is provided by the Pesticide Usage Survey Group, a Working Group on Disposal and the Working Party on Pesticide Residues. Where appropriate, these Panels include members drawn from a wide range of organisations such as the NFU, the Consumers Association, the Trade Unions and environmental interests. Together, the Panels and Committee provide a wealth of expertise on which advice to Ministers is based.

7. Only if the ACP is convinced that a pesticide can be used safely, subject to whatever conditions and precautionary warnings it thinks fit, will Ministers agree to give approval.

Approval Delays

8. Considerable criticism has been directed at the agricultural pesticide registration system for its failure to keep queues down to reasonable levels. I recognise that even now the waiting time for a new agricultural pesticides is too long. But we are tackling the problem in a number of ways. In the last 12 months the number of scientists working at the Data Evaluation Unit at

Rothamsted has been increased from 60 to 85, and we are pressing ahead with recruitment towards our target of 112 by April 1992. These additional resources are already bearing fruit with an increasing number of new chemicals being processed each year.

9. We are installing a major computerised office system to improve management control and internal communications. There is a continuing dialogue with the industry to improve the quality of their applications and reduce the number of rejections which divert valuable resources. For our part, we have reviewed procedures to speed up the processing of approvals and are on course to meet published targets; I fully expect that we will reduce the waiting time for new active ingredients to one year by 1994/95. Waiting times for other types of applications are also expected to fall progressively as newly recruited staff are trained and the benefits from other improvements take effect.

Reviews

10. Approval holders are aware of the obligation to submit immediately any data which show an adverse effect on humans, animals and the environment. If there is a significant concern over the safety of the pesticide, a review will be undertaken as a matter of priority.

11. We are continuing work on an extensive review programme to ensure that all pesticides registered before 1981 are re-evaluated and where necessary, brought up to current standards. In some cases companies will be required to produce and submit new studies. Where there is a safety concern Ministers will use their powers to revoke or suspend uses or amend the conditions of approval to safeguard people, animals and the environment. As part of the review programme, requirements have now been established to ensure that companies meet deadlines for the submission of data. This is an important step if delays in the

review programme are to be avoided and decisions taken on future approval status in a timely manner. At the same time, procedures have been adopted to allow products no longer receiving continuing commercial support from companies to be phased out from the market, where safety allows, in an orderly way. This minimises disruption to merchants and allows users time to identify alternative methods of control.

12. In the European context, we are discussing with other Member States how best to progress the EC review programme for all active ingredients approved in the Community before the Plant Protection Directive takes effect. I am optimistic that we will be able to integrate our own routine review programme into the Community's 10 year plan. I will return to the international aspects of our pesticides policy a little later in this speech.

Controls over Marketing

13. Only pesticides with provisional or full approval may be advertised and sold. Assessment of an application includes consideration of the proposed container and label directions. Labels will be required to highlight in a "statutory box", the mandatory conditions of use such as maximum application rates and minimum harvest intervals.

Controls over Storage

14. Once a product moves into the distribution system it is vital that it is stored safely. The storage of pesticides imposes heavy responsibilities and all involved must be competent to undertake such duties. All stores handling quantities over 200 kilogrammes or 200 litres must be under the control of a person holding the BASIS (British Agrochemical Standards Inspection Scheme) Certificate for Storekeepers. A Code of Practice for Suppliers of

Pesticides gives practical guidance on storage including the criteria for a safe storage site.

Controls over Use

15. When the product leaves the store, users have to follow all the statutory conditions of use. One of these requires that a particular pesticide is used only on the specified crops for which approval has been given. Minimum requirements are also set for protective clothing to be worn by operators.

16. Pesticides aimed at the amateur market for use in the home or garden must be specially packaged and formulated. They usually come in small ready-to-use packs and with a lower concentration of active ingredient than the agricultural or horticultural equivalent.

17. Farmers and growers have legal obligations under both the Control of Pesticides Regulations and the COSHH Regulations covering the Control of Substances Hazardous to Health. Anyone wishing to use a pesticide on a farm or holding may only do so after first determining whether it is necessary for the job to be done; then considering which product poses least risk but is still effective in controlling the pest, disease or weed problem to be tackled; and finally assessing which measures, such as procedural changes or engineering controls can be used to minimise exposure to the pesticide.

18. To ensure that users are aware of their responsibilities, the Ministry in cooperation with the Health and Safety Commission has produced a statutory Code of Practice for the Safe Use of Pesticides on Farms and Holdings. The Code covers all aspects of use, from the initial decision to use a pesticide to the ultimate disposal of unused chemicals and their containers.

19. It is one of the great strengths of the UK system that all farmers and growers must be trained and competent in the use of pesticides and that many are required to undergo testing and certification. The National Proficiency Test Council has recently issued its 50,000th certificate of competence. This is a remarkable achievement on the part of the NPTC which plays a vital role in ensuring the safe use of these products.

Enforcement

20. The enforcement of the Control of Pesticides Regulations and the COSHH Regulations is carried out by the Health and Safety Executive (HSE) through a continuing programme of inspections. HSE carried out over 40,000 visits to agricultural premises during 1989/90.

21. From 1 April 1992 some 430 local authorities will take over enforcement responsibility from Agriculture Departments in areas such as wholesale and retail outlets, catering establishments, offices and in the home and garden.

Disposal

22. At the end of a spraying programme there may well be small quantities of particular pesticides left in the store. There may also be stocks of older material whose approval has expired. It is essential that such stocks are disposed of safely. I was therefore happy to give my full support to the National Pesticide Retrieval Scheme recently initiated by the British Agrochemical Association and UKASTA. Under this scheme, those holding unwanted stocks are able to arrange the removal of surplus pesticides for safe destruction, at reasonable cost. There is therefore no excuse for holding surplus or illegal pesticides. I have urged all users to take advantage of this opportunity to clear their stores before the end of the year when the scheme ends.

Monitoring Use, Residues, Poisoning Incidents

23. When approval to market and use a pesticide is given that is not the end of the story so far as the regulatory authorities are concerned. There is a wide range of monitoring systems available to provide feedback on any problems arising from the misuse or abuse of pesticides which need to be tackled. This ensures that safeguards can be fine-tuned and the approval process made responsive to health and environmental needs. The data we collect is published annually. No findings are concealed, it is all readily available to the public and concerned interest groups. For example:

- pesticide usage survey reports are produced each year. The 1990 arable crops report shows that the total area treated has increased by 17% compared with 1988. However, the quantity of active ingredient applied was 4% less than two years before, reflecting the use of pesticides at lower rates.

- residue monitoring across a wide range of crops and food products is a major activity. This area will be covered in more detail by Mrs Radcliffe in another presentation today. But I should say at this stage that the results are reassuring and once again we make available all the facts.

Human Incidents

24. Despite all the care and all the precautions there are inevitably instances where things go wrong. The Health and Safety Executive's agricultural and factory inspectors investigate all reported incidents involving operators and the public. In 1990/91 84 suspected pecticide incidents in agriculture were investigated. 29 were confirmed by HSE's Pesticide Incidents Appraisal Panel. 43 people were involved including 25 members of the public. There is

no question that this is 43 people too many and the Government is concerned that spraying incidents, although isolated, should cease. However it must be remembered that this figure is in the context of 30 million hectares treated in England and Wales. Nevertheless, where any member of the public believes that an incident has taken place, it should be reported to the local office of the Health and Safety Executive for investigation.

25. As part of its continuing efforts in this area, the Health and Safety Executive has commissioned a 3-year research project. This research includes a pilot pesticide surveillance scheme in two health regions using freepost 'green cards' and a 24 hour 'hotline' for use by general practitioners, together with a clinical audit of suspected incidents. This is further evidence of the seriousness with which the Government views any such cases.

Illegal Poisoning of Wildlife

26. There is one aspect of pesticide usage to which I should refer, which causes us all concern. This is the abuse of pesticides by a small minority who use the chemicals in such a quantity and in such a way that they deliberately kill birds and mammals. The death of Red Kites, eagles and dogs through this dangerous and abhorrent practice is a cause for real anger. The risks to children and companion animals are all too clear. To combat such abuse we have launched a campaign against the Illegal Poisoning of Wildlife. Through a publicity campaign, through a freephone reporting service (0800 321600) and through strict enforcement we are aiming to stamp out this dangerous practice. We are most grateful to the industry and the countryside agencies for their help in this campaign.

Costs of the System

27. The systems of approval and monitoring I have described are comprehensive and costly. What may not be generally appreciated, although I am sure it is well understood by this audience, is that the pesticide industry pays the bill. Through a levy on all its production, industry supports not only the registration work, but also all post-approval monitoring. For 1991/92 this is expected to amount to some £8.5 million in addition to fees of around £1 million for the same year. The enforcement activities I have described are funded by the Exchequer.

R & D

28. In addition to the regulatory and monitoring activities undertaken by the Ministry, we also sponsor a major programme of research and development. The annual budget is currently around £20m and it is used to support work in the following areas:

- integrated pest management systems;
- methods of forecasting pest and disease incidence with a view to minimising pesticide treatment;
- investigating non chemical methods of control;
- monitoring of residues in food and water;
- non chemical methods of vertebrate pest control;
- methods of application - eg. controlling spray drift.

29. The Government is keen to develop joint R & D activities with industry and the British Agrochemicals Association is a major partner in a LINK programme - technologies for sustainable

agriculture. We are delighted that there is such close collaboration between us in this important area.

International

30. I said that I would return to international issues. The EC Registration Directive to be implemented in July 1993, will bring with it harmonised pesticide approval systems for the European Community. We are now involved in negotiations to establish the principles which will govern the interpretation of data requirements by the EC Member States. We aim to ensure that EC controls reflect the high standards operating here, both for agricultural pesticides and, in the establishment of a parallel directive, for non-agricultural pesticides. I hope that as a result of these efforts we will be able to look forward to the increased trading opportunities which a harmonised system offers and to speedier access by farmers to products available to their competitors. We will, of course, be vigilant to ensure that the advantages of the harmonised systems are not diminished by an excess of bureaucracy.

The Way Ahead

31. I hope I have set out clearly how comprehensively we control pesticide registration and usage in this country. We have a system to be proud of and one that is the envy of many other countries. We aim to provide a system in which the users of pesticides and consumers of food can have confidence. We believe that such confidence can only be maintained through a clear, convincing and honest statement of the facts. The best way to promote understanding is to be as open as possible and to demonstrate that we operate with care, on the basis of the best scientific advice.

32. There is undoubtedly more to be done by Government to correct public misconceptions. We must also meet our commitments for reducing delays in the approval of new chemicals and in dedicating resources to the review of the older pesticides. The industry too must play its part and I welcome recent initiatives aimed at placing the risk from pesticides in perspective. This is a message we must get across, if unneccesary food scares are to be avoided in future. When one recalls that the risk to health associated with pesticide residues is many times smaller than from other aspects of diet such as saturated fats and alcohol, it is easy to see that public perceptions about the dangers of pesticides can be wide of the mark.

33. I look to continuing cooperation with the pesticides industry in achieving a balanced view. I would urge industry to adopt the same open attitude to their procedures as that adopted by Government. To take this process forward, the Minister will be announcing to the Conservative Party Conference later this morning that a consultation paper on public access to information will be published shortly.

34. By committing ourselves to such a strategy, we are demonstrating our determination that pesticides should both be safe and be clearly seen to be safe. The public has a right to see the data on which the Government and its independent scientific advisers form their jugements.

35. We have already taken great steps forward in recent years by publishing a wide range of information on pesticides. This includes full residues monitoring data each year, and the detailed evaluation documents on new and reviewed pesticides. Public access to data supporting these evaluations is already available and we look forward to extending these arrangements further. The UK's openness on pesticides stands comparison with any system in the world.

36. We look to industry to match the Government's wish to provide the widest possible access to information. The Government is seeking to achieve a positive partnership with industry and consumers to ensure that our environment is protected and that food continues to be available in the quantity and quality which consumers have every right to expect.

PESTICIDES: PANACEA OR POISON

D M CONNING

The British Nutrition Foundation, 15 Belgrave Square, London, SW1X 8PG

ABSTRACT

The use of pesticides in conjunction with mechanisation, crop breeding programmes and irrigation has revolutionised world agricultural production in the last three decades. For the first time in human history, enough food has been produced to feed everyone. That people have not been fed has been the result of other, mainly political, constraints. Given the demographic changes expected during the course of the next century, it is by no means certain that this self-sufficiency can be maintained without the use of advanced technology, particularly chemical technology. Although biotechnology will help, it is unlikely to be developed sufficiently rapidly to obviate the use of pesticides, without which about one third of production is lost.

Nevertheless, there appears to be scope for reducing the volumes of pesticides used. There is a tendency to use higher concentrations than required and to make the applications at other than optimal times. Although there is no evidence that such usage results in unacceptable residues, the more efficient use may go some way to promote public reassurance.

As always, public confidence will not be restored until better education results in better understanding, though a return to food shortages may promote this process.

Pesticides have had a bad press for sometime now. Although this is a source of considerable frustration to those of us who care about the promotion of public understanding it is a fact that science and technology now proceed at such a pace, that no individual can keep up. As a consequence, a proportion of the public take fright and fall easy prey to those who exploit such fears for other reasons. The substantial majority still have faith, perhaps rooted in apathy, that someone somewhere is looking after their interests in terms of food supply and safety, and it is vitally important that this faith is retained. The simple fact is that without the means of improving food production and reducing the wastage that is inevitable, feeding the peoples of the earth will be a precarious task.

At present, the individuals of affluent nations consume around 14 MJ of energy per day (Table 1). Actual consumption is under 10 MJ on average so that some 35% of food production is lost during production, storage, distribution and processing (including cooking and wastage) and a further 5.0% enters long-term storage (and is also essentially lost). Less affluent nations consume less but the wastage rate is probably similar. It seems reasonable to assume that the optimal intake for all people is probably around the 10 MJ the best fed (using the terms literally) nations enjoy (Blaxter, 1987). The production deficit is approaching 35% therefore, though, ironically, if the problems of distribution and wastage could be resolved, the planet is probably self-sufficient at present. This remains, of course, a hypothetical possibility.

TABLE 1. World population energy consumption

Affluent	1.1 billion	14.1 MJ/day
Modest	1.2 billion	10.9 MJ/day
Poor	2.5 billion	9.7 MJ/day

Production deficit - 35%

Examination of some of the indices of agricultural production (Table 2) illustrate that current world food production is heavily dependent on the use of agricultural chemicals (pesticides and fertilisers) and a large expenditure of fossil fuel energy. Advanced nations can maintain or increase their productivity by better mechanisation and can reduce their use of pesticides (though not fertiliser) marginally, but the middle order nations (in production terms) such as China and India depend heavily on chemical inputs to maintain their newly acquired self sufficiency (FAO, 1987).

TABLE 2. Changes in food and agriculture indices 1980-86 (%)

Country	Crop Production	Pesticide Usage	Tractors	Calories per head	Popln
Africa	+14.6		+21	-1.2	+19
China	+26.4		+17.6	+13	+ 7.6
India	+12.9	+55	+67	+4	+12
Japan	+1.7		+38	+0.9	+4
Europe	+15.1		+17.9	+0.3	+2

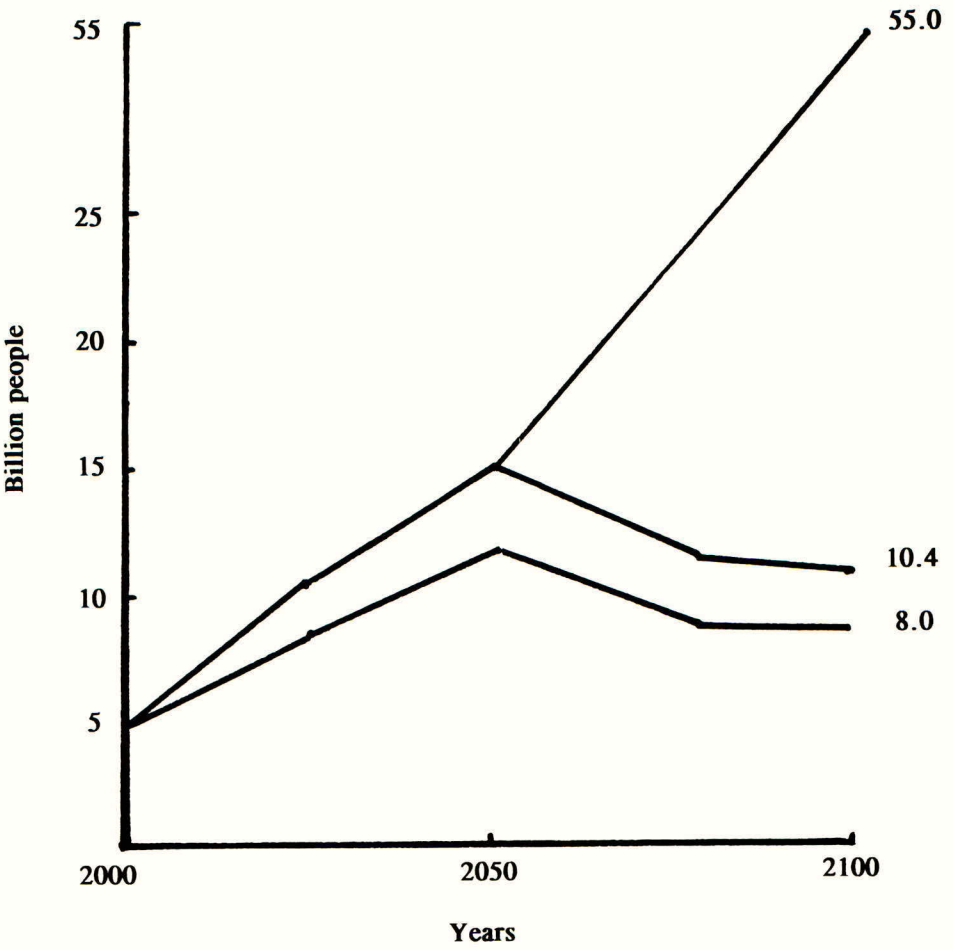
FAO 1988

The main problem is in the developing nations where production can be increased by the use of mechanisation to bring more land under cultivation, but not sufficiently rapidly, it seems, to maintain the energy requirements of the population. Unless their productivity can be increased and wastage reduced, the prospect for self-sufficiency is bleak.

The last forty years have demonstrated, therefore, that with the widespread and intensive application of advanced technology (including chemical technology) food production can just about provide the current needs. The prospects for the next forty years are not so rosy.

The prediction of future population trends is almost as difficult as the prediction of the climate but the most conservative of estimates is that the world population will be not less than 8 billion by 2,100, will probably be over 10 billion and could be much greater (Figure 1). Whatever the final figure, it is certain that this will be exceeded substantially before the population stabilises. In other words, we can expect to have to feed at least double the present world population within the next fifty years.

FIGURE 1



The chances of achieving this are not good at present, and are inconceivable without the full scale use of our chemical weaponry. Currently the greatest productivity achieved is less than 50% of the theoretical maximum in respect of the major cereal crops though in record years the figure has approached 90% in some countries. Overall it seems reasonable that productivity could be increased by around 30 to 40% as compared with the 150% that will be needed (Table 3). The target would move

TABLE 3. Crop yields (tonnes/ha)

	Wheat	Maize	Rice
Theoretical maximum	16	25	14
Developed (best)	7.0	9.6	6.3
Reasonable target	10.0	15.0	9.5
Developing	2.0	2.0	3.1
	Deficit 34%		

nearer if more land were to be brought under cultivation but this would require a radical re-appraisal of our concerns about global warming and a reversal of the substantial urbanisation at present underway. It is to be expected that advances in the development of more productive species of plants and animals, in terms of yields per hectare will make the target attainable if the availability of water can be assured. But all of these developments will require increased chemical inputs to protect crops against insect and fungal predators during growth and storage. Although better control of pests by harnessing biological methods and the use of biotechnology promise much, it seems unlikely that their successful deployment can be achieved sufficiently rapidly, that is, within the next five decades.

What would be the adverse consequences of continued, or indeed, intensified use of agrochemicals? These potential hazards may be classified under three headings:

Agricultural accidents
Ecological effects
Consumer effects

Accidental poisonings are negligible but associated problems such as dermatitis are claimed to occur with an unacceptably high prevalence. Whether or not this is true, it is imperative that users receive better education and training. Pesticides are by definition toxic, especially in concentrated form, and the potential hazard is much increased when the agricultural personnel are less accustomed to the advanced technology they represent, as is likely to be the case in many developing countries. More effort is required to provide the materials in safer format and to ensure that personnel are instructed in their use. Although it is theoretically possible to produce compounds that are toxic only to the target species, it is a practical proposition for only a minority of materials at present.

By their nature, pesticides exert an ecological effect - that is they alter the relationships between the species that form an ecosystem. Any kind of agricultural activity, of course, has a similar effect and the concern with pesticides apart from accidental or careless spillage, arises when there is persistence in some segment of the food chain resulting in accumulation to an eventual toxic concentration, however that is expressed. Limitation of the ecological impact is effected by the use of biodegradable pesticides where the chemical is present for a limited duration of time, by carefully timed applications where the bulk of the material is taken up by the target species and by ensuring that excessive concentrations are not

used. Regulatory clearance requires that such questions are addressed and the problem, if it exists at all, should henceforth be limited in severity. Regrettably, our understanding of ecological balance is elementary and there is a tendency for some enthusiasts to attribute what they consider to be adverse effects to the use of pesticides in the absence of other explanations and with very little justification. As always, better science will enable us to ask better questions and might even provide better solutions.

Good agricultural practice combined with restrictions on permissible concentrations of residues have resulted in a situation where the hazards to the consumer are more likely to arise from natural toxins and contaminants, than from pesticide residues. There is no published evidence of anyone being adversely affected by residues of pesticides in the food consumed. Nor is it likely that any such evidence could ever be produced because exposure to pesticides is exceedingly small, it is extremely rare for a particular foodstuff to be incriminated in human disease except in respect of immunological reactions, and the spectrum of diseases that could conceivably be involved is so commonplace. This has not prevented the generation of anxiety among some consumers, an anxiety that has proved so lucrative to some medical practitioners and which has formed part of the rationale for organic farming. Nevertheless we live in an age where ignorant perception seems to be as, if not more, important than established fact, and we can expect that effort will continue to minimise the likelihood that agricultural chemicals are carried through to foodstuffs, if need be by banning the chemical.

On the fact of it, no-one would argue that this is wrong, provided it is recognised that affluent nations with full bellies have no right to deny the expertise which has resulted in their food sufficiency, to those who remain perpetually hungry. In due course it is likely that with the development of pest-resistant species, nitrogen fixation and alternatives to fossil fuels many of the concerns that exercise us today will disappear (with the certainty that others will take their place) but it is very unlikely that these developments will occur in time to supplant present technology and yet maintain an adequate supply of food. It is imperative that those who claim to inform the public also seek to educate and reassure. The scaremongering tactics consistently employed at present, are dishonest, hypocritical and dangerous and are to be deprecated by anyone who cares about the welfare of this planet.

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FOOD QUALITY WITHOUT CHEMICAL CROP PROTECTION

PATRICK HOLDEN
Director British Organic Farmers

The Organic Food and Farming Centre, 86 Colston Street, Bristol BS1 5BB

In this paper I will discuss the extent to which organic production methods and chemical crop protection affect food quality.

The potential for the expansion of the organic sector deserves mention at the outset as the future scale of organic farming alters the significance of the debate. Some well known figures in the industry have made it clear, even within the last week that they do not expect organic farming to expand to a scale much beyond "a small niche in the market place". The UK government is currently considering the introduction of conversion support for farmers changing to organic methods. If the experience in Germany is anything to go by we can expect significant farmer uptake when such support measures are introduced in the UK. In one German state where these grants have been available for several years, the area of land in organic production has reached 3% of the total farmed acreage.

Definitions

1. Food Quality

A major premise of the organic approach is that plant and animal health cannot be defined as simply the absence of disease, but rather a state of health and vitality in which the organism is better able to withstand external challenges from pest and disease agents.

If this definition of health is accepted, there are clear 'downstream' consequences to definitions of food quality and to discussions about the need for plant protection. The overall management of the farming system is seen as the primary means of achieving food quality and of the maintenance of plant health on organic farms. Management tools include rotation of crops, the maintenance of soil fertility and structure, varietal selection, timing of planting, and thermal and mechanical disease control. The use of permitted crop protection inputs is, contary to popular opinion, normally only resorted to when primary management practices have proved insufficient.

2. Crop Protection

The absence of chemical crop protection is obviously not an adequate definition of organic husbandry. For the purposes of this paper I will assume that the title reference implies full organic management, according to Soil Association or UKROFS Standards, which include crop husbandry and nutrition.

Even the concept of plant protection itself is bought into question since susceptibility to attack from a pest or disease agent is seen as a consequence of mismanagement of the total environment in which the crop is growing. Of course there are occasions when appropriate intervention is necessary but this is the exception rather than the rule.

Food quality criteria

A growing body of evidence suggests that there are measurable quality differences between organic and conventionally grown foodstuffs. Three main categories have been used to assess food quality: **Appearance, Technological Suitability** and **Nutritional Quality.**

A fourth category, **Social and Environmental Impact**, which relates to the wider impact of the agricultural system, and includes such considerations as soil contamination and animal welfare, should be noted, although there are not normally any measurable adverse food quality effects stemming from these factors.

Elm Farm Research Centre recently brought together representative producers, processors, researchers and food writers to discuss the question of 'Food Quality'. The meeting identified six uses of the term 'quality' when applied to food. These are:

1. **Authenticity**
2. **Functionality (Technological)**
3. **Nutritional**
4. **Biological**
5. **Appearance**
6. **Ethical**

Although only functional quality, nutritional quality and appearance are normally recognised and used, it was agreed that the others are legitimate. However, their relative importance depends upon who you are, and what you want from the produce in question.

A number of surveys have indicated that what purchasers and consumers of organically produced food want are:-

1. That the food is free from agrochemical residues
2. That it tastes different from (and possibly better than) conventionally produced food
3. That health benefits (other than food safety) accrue from consuming it
4. The assurance that the product comes from an environmentally benign production system

It has often been stated that there are no scientifically demonstrable differences between organically and conventionally produced food. As a consequence, the full range of quality requirements of consumers of organic food are not being met. In fact, there is an increasing body of scientific work that does demonstrate that there are differences. This work, using generally accepted analytical methods for determining residue, nutrient and mineral content, plus storage trials and animal feeding trials cannot be regarded as definitive - there is not enough of it and it has not been repeated often enough - but neither can it be dismissed. It shows that lower levels of undesirable components (pesticide residues, sodium, nitrates) and higher levels of desirable components (real protein, and vitamins) are achievable with organically, as opposed to conventionally produced food. Greater benefits under non-artificial storage conditions have also been demonstrated.

Appearance can be assessed using visual or textural criteria. It is widely assumed that organic fresh produce is unable to meet the same levels of cosmetic quality as conventionally produced fruit and vegetables. It is questionable whether any current cosmetic shortcomings will remain a long term problem, given advances in plant breeding, further research and development and improved husbandry techniques. Consumer tolerance of minor cosmetic imperfections may also increase.

Technological suitability can be measured using criteria such as post harvest storage quality, shelf life, and suitability for processing. There is some evidence that organic food products are superior in these respects.

Storage losses (%) for vegetables grown with different fertilisers.

	Fertiliser type	
	Mineral	*Organic*
Carrots	45.5	34.5
Kohlrabi	50.5	34.8
Beetroot	59.8	40.4
Various vegetables (average)	46.2	30.0

Source: Samaras 1977

Nutritional Quality can be measured positively in terms of taste, dry matter, mineral trace element and vitamin levels. Again there is some evidence that organic methods have a beneficial impact on these aspects of food quality.

On the negative side, an assessment of food quality in relation to non use of chemical crop protection would be incomplete without reference to the lower incidence of pesticide residues present in organically grown foods.

Pesticide residues in fruit and vegetables measured by the Chemischen Landesuntersuchungsanstalt Signaringen (% in brackets).

	Organic				*Conventional*			
Year	*Sample size*	*Residue free*	*Below 0.01 mg/kg**	*Above*	*Sample size*	*Residue free*	*Below max. perm. lev.*	*Above*
1983	43	42 (98)	1 (2)	0 (0)	484	222 (46)	249 (51)	13 (3)
1984	108	100 (93)	7 (6)	1 (1)	383	180 (47)	191 (50)	12 (3)
1985	43	37 (86)	6 (14)	0 (0)	456	244 (53)	200 (44)	12 (3)

*less than 0.01 mg/kg represents presence in trace amounts only.
Source: Reinhard & Wolff 1986

Pesticide residues in vegetables by type measured by the Chemischen Landesuntersuchungsanstalt Sigmaringen, 1985 (%in brackets).

	Organic				*Conventional*			
Vegetable	*Sample size*	*Residue free*	*Below 0.01 mg/kg**	*Above*	*Sample size*	*Residue free*	*Below max. perm. lev.*	*Above*
Red cabbage	1	1	-	-	2	1	1	-
White cabbage	1	1	-	-	5	4	1	-
Mangold	1	1	-	-	1	1	-	-
Lettuce	5	5	-	-	48	9	36	3
Courgette	1	1	-	-	1	1	-	-
Green pepper	1	1	-	-	32	9	18	5
Tomatoes	4	3	1	-	18	13	5	-
Kohlrabi	3	3	-	-	16	13	3	-
Carrots	6	2	4	-	7	6	1	-
Beetroot	2	2	-	-	2	2	-	-
Total	25	20	5	-	132	59	65	8
Per cent	100	80	20	-	100	45	49	6

*less than 0.01 mg/kg represents presence in trace amounts only.

Pesticide residues in fresh fruit and vegetables sampled in Basel, Switzerland, 1980-83.

	Conventional	*Organic*
Number of samples	856	173
No residues detected (%)	60.9	97.1
Tolerable residue levels (%)	32.9	2.9
Excessive residue levels (%)	6.2	0

Source: Schupbach (1986)

Pesticide Consumption in Diet

Food	Av. daily consumption Milligrams
Wheat	3.000
Potatoes	0.150
Lettuce	0.750
Tomatoes	0.075
Apples	0.750
Oranges	0.750
Bananas	0.075
Carrots	0.375
Cabbage	0.075
Onions	0.008

Average GB diet 1990 from FAO

Although current levels of pesticide contamination may be very much below the ADIs (Acceptable Daily Intake) the long term cumulative effect of a so called 'cocktail' of pesticide residues cannot be predicted. In any case, according to Hatchcock(1985) some ADIs are based on incomplete data from studies where the protocol is no longer considered valid.

In addition it would seem important to consider the possible consequences of increased residue levels on detoxifying mechanisms. For instance, Berger et al (1980) found that OP insecticides can reduce the level of ascorbic acid in plants, and this can affect the ability of the liver to de-toxify.

A further problem is that residue testing procedures may be very inaccurate. In a MAFF test (Farmers Weekly, 13.7.90 p15) of residue testing laboratories, fat samples were spiked with 4 pesticides: beta HCH, gamma HCH, dieldrin and pp.DDE.

Results were returned from 29 laboratories. These should have shown 20mg/kg (ppm) in the spiked samples. In fact, 21 labs found no traces. Four results were about right and one analysis was five times too high.

Collectively, these factors are cause for concern and justify a greater emphasis on consumer protection by the encouragement, through increased levels of research and development, of husbandry techniques, avoiding the use of agrochemicals.

What has not yet been conclusively demonstrated is that organic food directly contributes to human health. Clearly, in common with all types of food research, there is a major methodological obstacle to tacking this question. As with other investigations, researchers involved in this area are forced to draw inferences from animal trials. From an admittedly limited number of trials, evidence has been identified of increased fecundity, decreased mortality and greater feeding preference. The methods used in all of this work are recognisable and acceptable to all researchers.

More novel methods of assessing nutritional quality holistically, such as studies with animals fed on organic diets, image forming techniques using copper chloride crystallisation and chromatography, and physical-chemical techniques such as counting photon emissions from food samples have all measured significant differences between organic and conventional foods.

The employment of such novel methods is an attempt to identify a characteristic of food other than currently measurable components, such as nutrients, vitamins and residues. This characteristic, which could be called **'vitality'** is thought by some to be important to the health of all living organisms and can be passed on through the food chain. Another method recently used to analyse differences in food is the measurement of 'low level luminescence' (structural energy). It was developed by German and Russian scientists during the 1940s and is based upon the view that low level luminescence is stored in the DNA of all living cells. Measurements will vary according to the well being of that cell.

It is recognised that these approaches are at - or even beyond - the frontiers of currently acceptable scientific practice. None the less, under controlled conditions and repeated a number of times, differences have been observed between organically and conventionally grown potatoes.

Concern has been expressed about the potential for increased levels of naturally occurring plant secondary metabolites in organic crops but there is no evidence to substantiate this. The only data so far available (**Elm Farm Research Centre 1990 glycoalkaloid levels in conventional and organic potatoes**) indicated that glycoalkaloids in organically grown potatoes did not exceed normal levels.

Summary

Although there are insufficient data to conclusively demonstrate that food quality is always enhanced through organic husbandry techniques, there is growing evidence that a range of specific quality benefits are commonly achieved using organic methods, and that agrochemical intervention can produce both direct and indirect undesirable side effects.

Against a background of growing consumer concern there is a clear need for more research and development investment in production techniques which avoid the use of plant protection agrochemicals, with their attendant risks to food quality, human health and the environment .

DISCUSSION

M.B. Green: Is there any real evidence that organically grown food is more healthy than food produced conventionally?

P. Holden: There is not a substantial body of data to prove this, but there is a growing body of data to indicate that there are differences. However, public perception and intuition, which should not be dismissed lightly, indicate concern of the negative impact of agrochemicals. Nevertheless, I do agree more research on this topic is needed.

C.L. Berry: In terms of deleterious effects in organically-grown food there are reports from Germany in recent years of a reappearance of ergotism from the use of untreated cereal seed. Certainly mycotoxins do appear in untreated seed. On the question of long term effects of pesticide exposure, it is difficult to assess this directly. However, a study of all Canadian farmers (353,000) exposed regularly to pesticides, reported in the Journal of National Cancer Institute, over a 15 year period show that they had a lower incidence of all types of tumour compared with the overall population though they had a higher incidence of skin cancers thought to be related to exposure to sunlight.

P. Holden: There is the possibility of natural toxins contaminating organically-grown food but, if you are aware of these problems, you can take steps to avoid them.

On the question of the farmer study, there are always so many variables that it is impossible to be certain of what you are examining.

C.L. Berry: The point I was making was that in this excellent study, for whatever reason, the farmers were healthier and lived longer than the non-farming population. It is always easy to look for adverse effects but we seldom look for beneficial effects which would serve us better. Why, for example, is the incidence of stomach cancer falling so dramatically in the U.K.?

J. Gilmour: I am very disappointed in Patrick Holden's reaction in attempting to dismiss the very rigorous study cited by Professor Berry whilst supporters of organic farming are ready to accept less robust studies which indicate that there may be deleterious effects from pesticide usage. On a second point concerning organic farming, there are two methods to achieve crop protection - one

is husbandry, the other is conventional breeding which depends on chemicals, albeit "naturally - occurring" chemicals within plants. Developing technology will allow specific "natural" biocides to be produced by genetically-engineered resistant crops. However, to achieve the necessary levels of protection indicated as necessary in Professor Conning's talk then this is unlikely in the short term. Furthermore, these "natural" biocides are simply chemicals whose properties are not necessarily advantageous. Examples are afforded by the insect-resistant but toxic potatoes bred in the U.S. and the pest resistant celery which caused allergenic responses to the processors. It is important to get the balance correct between "man-made" and "natural" chemicals in crop protection.

P. Holden: I agree that scientific advance, particularly biotechnology, has great potential for crop protection. However, all new approaches have to be considered from a number of viewpoints, be they environmental, ethical or social. Consequently, some of these advances will be appropriate to the organic grower but they must be examined carefully with particular reference to increased potency.

INVESTIGATIONS AND MONITORING OF PESTICIDE RESIDUES IN FOOD CROPS IN GERMANY

J.-R. LUNDEHN

Federal Biological Research Centre for Agriculture and Forestry, Department of Plant Protection Products and Application Techniques, Chemistry Division, W-3300 Braunschweig

THE FEDERAL BIOLOGICAL RESEARCH CENTRE FOR AGRICULTURE AND FORESTRY

The Federal Biological Research Centre for Agriculture and Forestry - Biologische Bundesanstalt für Land- und Forstwirtschaft (BBA) - is a research institution for plant protection attached to the Federal Ministry of Food, Agriculture and Forestry (Bundesministerium für Ernährung, Landwirtschaft und Forsten) in Bonn. The tasks of the BBA are defined by the Plant Protection Act (Pflanzenschutzgesetz), dated 15 September 1986, and involve - as a federal authority - research on plant protection and the performance of administrative functions. The latter include examination and authorization for the marketing of pesticides and the registration of equipment used in the protection of plants and stored products. Furthermore, the BBA advises the Federal Ministry of Food, Agriculture and Forestry and assists in reaching decisions relating to plant protection.

In all of its research efforts, the BBA seeks - in close cooperation with the Plant Protection Service - to contribute to the development of more economical methods of plant production in agriculture and forestry with a minimum of ecological damage (Integrated Pest Control). It helps to maintain European Common Market standards of quality for public health and to prevent harm to animals and the environment through undesirable side effects of pesticides.

A Scientific Advisory Board of 15 members from both scientific and applied agriculture advises the BBA on research. The board enables the BBA to stay in close contact with scientists and research institutions working in the same or related areas as well as with farmers.

Within the BBA the Department of Plant Protection Products and Application Techniques is responsible for the mandatory examination and authorization of pesticides.
It is the applicants responsibility to provide the Department with all necessary information or data. Authorization by the BBA for the marketing or import of these chemicals or biological products is given only with the consent of the Federal Health Office (Bundesgesundheitsamt) and the Federal Environmental Agency (Umweltbundesamt). It needs to be proved that pesticides do not have any harmful effects on human and animal health or on groundwater. Harmful effects, particularly with regard to the environment. should also be avoided as far as possible.

Within the Department for Plant Protection Products the Chemistry Division is among those responsible for the examination of the residual behaviour during the official authorization procedure. Beside its official work the Chemistry Division and three other divisions of the Department conduct research on problems concerning the examination of pesticides and their application. The results are published in
- Richtlinie für die Prüfung von Pflanzenschutzmitteln im Zulassungsverfahren

(Loose-leaf collection of guidelines for the examination and official authorization of pesticides and registration of plant protection equipment in the Federal Republic of Germany).
The list of authorized pesticides and registered equipment is published at regular intervals in the Federal Gazette (Bundesanzeiger).

INVESTIGATION OF THE RESIDUAL BEHAVIOUR DURING THE AUTHORIZATION PROCEDURE

In addition to the obligatory assessments of efficacy and toxicological properties of pesticides the subject of residual behaviour is traditionally a major topic for their authorization. In the Federal Republic of Germany the first Regulatory Ordinance on Maximum Residue Limits (PHmV) was published in 1966. Since then discussions about pesticide residues in food have never really ceased. Proposals for MRLs are worked out during the authorization procedure for pesticides. The proposals are evaluated on the basis of supervised trials according to "Good Agricultural Practice" (GAP) and the toxicology of the product. Likewise other uses of pesticides have to be considered.
Basically it is the applicant's responsibility to provide the BBA with all necessary information and data. It is recommended that the method and the extent of these investigations should be in line with the guidelines of the BBA and in consultation with the Department for Plant Protection Products and Application Techniques. In principle, the assessment must be done for each compound and each main area of use (crop).

In accordance with the authorization requirements, the following information must be provided by the applicant for the residual behaviour of pesticides:
- Degradation, transformation and metabolism in/on plants, where necessary for each different crop or plant group separately, with respect to requested areas of application.
- Uptake, distribution and mode of action concerning the residual behaviour in/on plants.
- Residues in foodstuff of plant origin.
- Residues in animal fodder of plant origin.
- Residues in rotational crops.
- Residues in prepared and processed food of plant origin.
- Residues in foodstuffs originating from animals fed on fodder containing residues.
- Summary of results on investigation and evaluation.
- Proposed Maximum Residue Limit (MRL) together with supporting data and, where applicable, notification of any such limit already established in another country.
- Proposed Pre-harvest Interval (PHI) together with supporting data.

Besides the information listed above other information on the residual behaviour has to be taken into account. That is:
- Residues in/on imported food and
- Residues in/on food of animal origin resulting from using the active ingredient and its degradation products outside plant protection such as a veterinary drug or disinfectant.

The requirements for the evaluation and investigation of the residual behaviour during the authorization procedure are laid down and published by the BBA at present in seven guidelines, i. e.

- BBA-guideline part IV, 3-1
General observations concerning the manner and coverage of the required investigations and supporting documentation
- BBA-guideline part IV, 3-3
General recommendations for the design, preparation and realization of residue tests
- BBA-guideline part IV, 3-4
Residue tests in processed plant products
- BBA-guideline part IV, 3-6
Mathematical methods for calculation of Maximum Residue Limits (MRLs) and Pre-harvest Intervals (PHIs)
- BBA-guideline part IV, 3-8
Portions of commodities to be analysed
- BBA-guideline part IV, 3-10
Residue tests in rotational crops
- BBA-guideline part IV, 3-15
Protocol of results
Further guidelines are being prepared.

The design of residue trials has to take into account the conditions and factors which lead to the highest residue levels following Good Agricultural Practice. The objective will be reached normally by provision of:
- eight residue disappearance studies,
-- from two growing seasons,
-- with the commercial formulation,
concerning
- major areas of cultivation,
- varieties of crops,
- usual application techniques.
The requirements for authorization of pesticides in the Federal Republic of Germany are very high and specific and only comparable with those in a few countries, for example, the United States of America.

MONITORING

Advice and surveillance of the farmers are not within the goals and objectives of the BBA. These areas are the responsiblity of the Laender. Annually they take thousands of food samples for control purposes. The results of this work show that the farmers follow the label instructions for pesticides, which are laid down by the BBA.

Since April 1988 a monitoring system for foodstuffs has been established in the Federal Republic of Germany as a pilot project. This monitoring and control system aims to determine the actual contamination of important foods with residues and pollutants such as pesticides, nitrate, heavy metals and polychlorinated biphenyls (PCBs).

Important objectives for the project are:

(1) The determination of the consumer exposure to noxious substances and any related health hazards (consumer-oriented objective),
(2) the detection of detrimental effects during manufacture and production for the purpose of finding the causes (cause-oriented objective) and
(3) the early detection and elimination of potential harmful effects (preventive objective).

The research project, scheduled for five years, is sponsored by the Federal Minister for Health and the Federal Minister for Research and Technology. It is implemented by the Federal Health Office in cooperation with 17 laboratories in the initial stage. Since April 1990 (main stage) 36 laboratories of the official food inspection agencies of the former 11 Federal Laender are involved in this project.

Implementation

During the initial stage of 18 months, 9000 food samples in total (6000 samples per year) were analysed. Samples were taken from potatoes, white cabbage, lettuce, apples and strawberries as well as from milk, cattle and pig. Fat, liver and kidney from these animals were analysed, and, where the internally specified limits were exceeded, also the muscle tissue. In addition to that, tomatoes, carrots, spinach and peaches as well as eggs and trout were included in the programme during the first part of the main stage. In the second part of the main stage (beginning on 1 April 1991) peppers and grapes will also be considered. Besides conventionally produced foods, organically produced foods have also been taken into consideration during the main stage. As compared to the initial stage, the number of samples taken per year had doubled to an amount of 12000.

The analysis of residues and impurities is carried out by procedures appropriate for the respective foods. The scope of substances mainly includes chemical elements, nitrate, pesticides and PCBs. During the main stage, the scope of pesticides was considerably extended (from 120 to 250 substances) by using on agreed multi-residue method (German Society for the Advancement of Scientific Research (DFG)-S8-Becker, DFG-S19-Specht).

First results concerning pesticides residues in vegetable foods, examined during the initial stage (September 1988 to March 1990) of the Research Project "Monitoring (of foods) in the Federal Republic of Germany"

During the first year of monitoring (1 October 1988 to 30 September 1989) 6000 food samples were tested for a multitude of pesticides, chemical elements, PCBs and nitrate by 17 laboratories of the official food inspection agencies of the former 11 Federal Laender.

The results of monitoring foodstuffs enable us to make representative and nationally applicable statements on the contamination of foods on the market.

The contamination of potatoes and white cabbages with pesticides was very low on the whole. Out of among approximately 1,300 representative samples from these two crops only 7 samples exceeded the Maximum Residue Limits specified in the Regulatory Ordinance on Maximum Residue Limits of Plant Protection Products.

The monitoring results for apples (about 750 samples), lettuce (about 600 samples) and strawberries (about 950 samples) showed a considerably higher percentage of samples with detectable pesticide residues (including those substances which are found at present only as environmental contaminants): about 47 % in apples, about 69 % in lettuce and about 80 % in strawberries. In a considerable number of samples more than one substance was detected: in 18.7 % of apple samples, in 47.9 % of strawberry samples,

and in 29.8 % of lettuce samples; 2 % of apples and 6.5 % of strawberries contained 4 to 7 substances, 3 % of lettuce 4 to 5 substances.

It is true that, as a rule, the residue concentrations detected in those cases were low, but for the consumer protection everything should be done to improve the residue situation of our food.

In 3.5 % of the tested apples the measured values exceeded the applicable Maximum Residue Limits, in the case of lettuce these were 5,8 % and in the case of strawberries 6.2 %; sometimes the measured values of several substances in one sample exceeded the Maximum Residue Limits. It is obvious that the Maximum Residue Limits specified in the Regulatory Ordinance on Maximum Residue Limits are obviously not followed in a relatively large quantity of apples, lettuce and strawberries on the German market. To ensure compliance with the Maximum Residue Limits in food in the interest of protection of the consumer's health, the contamination of food with residues has to be kept as low as possible.

In addition, there were strong seasonal fluctuations in the contamination with pesticides in apples, lettuce and strawberries. Apples offered for sale from October till March were considerably less often contaminated and contained lower levels of pesticides than in the other months. Lettuce were less contaminated between April and September, strawberries between June and August. These periods correspond to the growth (except apples) and marketing periods for these crops in Germany. Consequently the consumers themselves might influence the intake of pesticide residues via these crops by buying preferably these products during the mentioned seasons and by making lower demands as to their outer appearance.

However a large number of samples the monitoring of foods did not reveal any detectable pesticide residues (potatoes: 88 %, apples: 53 %, strawberries: 20 %, lettuce: 31 % and white cabbages: 92 %). This shows that extensive applications of pesticides are not always required.

Experiences

The chosen procedure of developing nationally representative and reliable descriptions of current contamination of selected foods with undesired or toxicologically hazardous substances, within the scope of the official food inspection, has already turned out to be practicable.

The procedure is proved to be adequate for the problems, effective and partially directive. The objectives set for the end of the initial stage were fulfilled, so that improvements of methods, which are continuously adjusted to new conditions, will also be utilized during the main stage of the project.

The organizational conditions, in particular the chosen typ of cooperation between Federal Government, Laender (Ministries of the Laender, "Monitoring commission", "Monitoring Working Group") and the participating food inspection offices (permanent contacts, meetings of analysts, meetings of data collection experts) proved to be effective and ensure a successful completion of the project.

First consequences from the monitoring results can be seen. They concern e. g. the elimination of detected causes of contamination or, due to the multitude of monitoring findings on the multiple contamination of foods with pesticides, initiation of a joint discussion on the future application of pesticides between the producers' associations and authorization agencies.

The monitoring results did not only give rise to some complaints about food quality; they also served the purpose of clarifying a number of questions raised by consumers and requests from other authorities. Even consumption-related and seasonal recommendations for the consumers could be derived from these findings.

An overall evaluation of the initial stage leads to the conclusion that the pilot project will be successfully completed and thus the prerequisites have been fullfilled for an acceptance of this programme in the official food inspection of all Federal Laender.

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DISCUSSION

D. Conning: Were you able to locate the farms producing crops with residue levels above the MRL's?

J.R. Lundehn: No.

P.J.I. Snell: What chemicals were most commonly associated with the quoted high residue levels?

J.R. Lundehn: I don't remember the details, but they were more associated with strawberries. However, many of the incidences were with chemicals not registered in Germany and consequently with zero tolerance occurring in imported produce.

PESTICIDE RESIDUES: CURRENT DEVELOPMENTS

FRANCES RADCLIFFE, PESTICIDES SAFETY DIVISION, MINISTRY OF AGRICULTURE, FISHERIES AND FOOD, LONDON, SW1P 3JR

1. Pesticide residues in food, water and the environment are frequently in the news. There is so much to say on this issue that the problem for any speaker is not lack of material, but the selection of key issues to discuss. Four topics will be considered: first, internal UK developments in terms of updating our own statutory Maximum Residue Levels (MRLs); secondly, developments in the European Community and elsewhere; thirdly, the results of UK monitoring; and finally, an issue of great importance to consumers and hence to the food retailing and producing industries, that is whether or not produce treated with pesticides should be labelled.

2. When compared with countries like Germany, the United Kingdom is a comparative newcomer into the field of statutory MRLs. Until 2 August 1988 there was no such thing as a statutory MRL in the UK. The reasons for what might be seen as our tardiness were that the key control on pesticide residues was seen not to be the setting of statutory residues levels but rather the approvals process. It was also felt that Maximum Residue Levels would be widely misunderstood as safety levels. There are certainly those who consider when they read some comments in the media that their reservations about the setting of statutory limits have been all too clearly proved correct. But there are others who consider that statutory MRLs provide extremely useful benchmarks against which to assess residues in food, and these people are now in the majority.

3. It is perhaps helpful to look back at the predecessors to UK MRLs. MRLs set by the UN WHO/FAO Codex Alimentarius Commission have been in existence for over 20 years. Codex covers commodities moving in international trade where residue levels may be a problem. The earliest EC Directive setting MRLs was agreed in 1976. Under this Directive on residues in fruit and vegetables (76/865/EEC), Maximum Residue Levels were voluntary. Member States were free to set higher limits or no limits at all. The point of the Directive was that if produce complied with the limits set by the Community then no Member State could refuse to accept it. Two further EC Directives were agreed in 1986. One covering cereals and the other products of animal origin (86/362/EEC and 86/363/EEC). Under these two Directives, statutory MRLs had to be set for produce entering the Community from third countries or exported to other Member States. This arrangement allowed the UK to continue to rely on monitoring carried out by the Working Party on Pesticide Residues. Things were however changing in the UK and in our first Consultative Document on Pesticide Residues a full statutory system was proposed. Responses to this document were very much in favour of a statutory system and the ultimate result was the Pesticide (Maximum Residue Levels in Food) Regulations 1988.

4. In order to see both our Regulations and the results of monitoring in context it is essential to understand the exact meaning of the term Maximum Residue Level when applied to pesticide residues. There are three key stages involved in the setting of MRLs: first, the maximum level of any residue left in a foodstuff must be assessed; secondly, the toxicology of the pesticide must be assessed; third, an intake calculation must be undertaken. Only if it is clear that the intake of a pesticide from diet is within the relevant Acceptable Daily Intake (ADI) will that pesticide be approved for the proposed use.

5. When a pesticide is used it may or may not leave a residue in food. In most cases it will not. For example, 75% of the agricultural pesticides used in the UK are herbicides, many uses of which leave no detectable residues in food. All applicants who request approval for the use of a pesticide on an edible crop must supply residues data. This is obtained from a series of trials. Emphasis must be directed towards the worst case, that is to those conditions and factors which are likely to lead to the occurrence of the highest residue following the proposed pattern of use. This will include maximum application rates, the maximum number of applications, and the shortest proposed interval between the last application and harvest. From these trials the predicted Maximum Residue Level is established.

6. The toxicological assessment of a pesticide is based on laboratory studies which are the only practical way to simulate ingestion of the minute amounts of pesticide which may occur as residues in food. A number of dose levels are used in these laboratory studies to identify the maximum dose at which specific treatment related effects do not occur. This is called the no observed effect level. To take account of variations between animals and man and variations in sensitivity between individual men, a safety factor of at least 100 is generally used to calculate an Acceptable Daily Intake (ADI). This is defined as the amount of chemical which can be consumed daily in the diet over a whole lifetime in the practical certainty on the basis of all known facts that no harm will result.

7. The link between Maximum Residue Levels and ADIs is made through intake calculations. The intention is to ensure that even consumers who eat above average amounts of a particular food, or special groups of consumers, such as infants and children, will not have intakes of pesticides which exceed the ADI. Thus it is necessary to predict the level of dietary intake by considering

both the concentration of the pesticide, if any, in the relevant food or foods and the amount of that food actually consumed. Data from surveys such as the National Food Survey are used to estimate how much an above average consumer of certain foods would eat and then to estimate the extreme intake of the pesticide.

8. It must be stressed that pesticides will not be approved for use unless it is clear that consumers in the worst case will not ingest quantities of residues in excess of the relevant ADI. Full details can be found in the technical policy paper published at Appendix IV of the Advisory Committee on Pesticides Annual Report 1988.

9. It can thus be seen that although MRLs are not safety levels, they do take account of consumer safety aspects. They are intended primarily to act as a check that good agricultural practice in the use of pesticides is being followed and to allow international trade to take place. It is indeed during the approvals process for pesticides that the potential exposure of consumers to residues in food is carefully assessed and uses are only approved if the likely residues present no risk to health.

10. MRLs are not easy to explain, partly because the terminology, with its use of the word "maximum", implies that they are safety levels. Moreover, where residues of veterinary products are concerned the calculation process is different and limits are linked to safety in a way that is not the case for pesticides.

11. Limits set in 1988 covered 61 pesticides used on the most important components of the average national diet. They included cereals, meat, dairy products and a wide range of fruit and vegetables. The Regulations implemented the two EC Directives on cereals and products of animal origin. Levels set for fruit and vegetables were largely based on Codex limits. Recently, a third

Consultative Document has been issued proposing various changes to our Regulations. Over 900 new limits are proposed. Over 500 are the result of extrapolations, such as from carrots to parsnips and they bring in up to 19 crops not previously included in our Regulations. Over 400 limits are based on recent European Community discussions. These limits bring in residues from three additional pesticides. Seven new limits for individual pesticide/commodity combinations are proposed based on advice from the independent Advisory Committee on Pesticides or on Codex or EC levels. The second category of changes concerns amendments to existing limits. With one exception, all amendments involve reducing MRLs. The one exception is for residues of triazophos in carrots where has become clear that the MRL included in our 1988 Regulations was set too low. Finally, two changes are proposed to bring our new regulations in line with EC legislation. These changes are to apply MRLs to produce to be used for animal feed as well as for human consumption and to use the new EC agreed format for listing commodities for which residue levels will be set. The results of the consultation are now being considered. We also need EC clearance to go ahead: under the Technical Standards Directive (83/189/EEC), a formal three month period of consultation is required. The period ends in November.

12. Comments on our proposals have been generally favourable, although it is clear that there are still some misunderstandings about how MRLs are set and enforced. Under the Ministry's Food Safety Directorate's new procedures, anyone wishing to see comments on a consultative document can now do so at our Whitehall Place library. The proposed decrease in the limits for contact organophosphorus insecticides for use on cereals has caused some comment but no evidence to suggest these proposed new limits are wrong has been produced and no objections have been received from those responsible for the manufacture of the active ingredients concerned. The position on residues of triazophos in carrots was

set out clearly in the Consultation Document and provides a useful illustration of how MRLs are set. The point is that approved uses of triazophos can lead to residues above our statutory level but the definition of Maximum Residue Levels is "the maximum concentration of a pesticide residue (expressed as milligrams/kilogram) legally permitted in or on food commodities or animal feeds." MRLs are based on Good Agricultural Practice (GAP) data and the foods derived from commodities that comply with the respective MRLs are intended to be toxicologically acceptable. Based on the Codex definition, Good Agricultural Practice is defined as:

> "the nationally authorised safe uses of pesticides under actual conditions necessary for effective and reliable pest control. It encompasses a range of levels of pesticide applications up to the highest authorised use, applied in a manner which leaves a residue, which is the smallest practicable. Authorised safe uses are determined at the national level and include nationally registered recommended uses which take into account public and occupational health and environmental safety considerations. Actual conditions include any stage in the production, storage, transport, distribution and processing of food commodities and animal feed."

MRLs are thus intended to reflect the maximum residue likely to arise from the approved use of a pesticide. In the case of the MRL for triazophos in carrots, this was not the case. The results of surveillance monitoring, again described in the Consultation Document, illustrate the problem. Monitoring data from samples purchased from April 1989 to March 1990 show that residues of triazophos in 36% of UK mature carrot samples and 22% of UK immature carrot samples exceeded the UK MRL of 0.1 mg/kg. When

trials data was examined, it was clear that residues above 0.1 mg/kg could be expected to arise from approved use.

13. Some comment on the consultation document concentrated on the application of MRLs to produce intended for animal feed and whether limits should be set under specific feedingstuffs regulations. The point is that we are not seeking specifically to set MRLs for feedingstuffs as a completely separate exercise, but rather to ensure that treated produce whether it is sent for human consumption or for animal consumption contains no more residues that should arise if pesticides had been used as approved. Only if higher rates of application or shorter harvest intervals were recommended for food crops going for animalfeed would a different MRL be justified.

14. Finally, the new EC agreed format demonstrates where the Community is heading. It is intending ultimately to cover every eventuality. This is not how the UK has operated to date. UK MRLs have generally been set where residues are expected to arise or where we particularly wish to prohibit the use of a pesticide. Our MRLs for the organochlorine pesticides come into this latter category. Limits have been set at the limit of determination to preclude use. In future, for every commodity, the Community will aim to set a figure. Where a pesticide is approved for use within the Community or a limit is needed for imported produce, then an appropriate MRL will be set. Where there is no approved use within the Community and it is considered that no limit is justified to cover imports, then the Community will set the level at the limit of determination of a recognised method of analysis.

15. EC proposals for new Maximum Residue Levels always seem to be tantalisingly close but as yet no formal proposal has been made. The new framework Fruit and Vegetables Directive agreed last year (90/642/EEC) remains just a framework with as yet no MRLs included

in the Annex. At Commission Working Group level there have been three years of intensive discussions. A Commission proposal to the Council on a first priority list of 20 pesticides is indeed now likely to be made soon. Some additional MRLs for cereals and products of animal origin will also be proposed. It will be essential for companies responsible for these pesticides to check urgently that the MRLs proposed are in line with approved uses in the UK and elsewhere. Advice from the scientific Community would also be extremely welcome. Retailers and others who carry out monitoring should also alert the Ministry urgently if they foresee any problems with any of the levels being proposed. Once the proposal is made, the next step will of course be for deliberations to take place in Council Working Group pending agreement by the Council.

16. The Commission has also set out an ambitious programme for setting future harmonised MRLs for existing pesticides, aiming to cover 20 new active ingredients each year. Given progress to date, it is not perhaps unfair to comment that it will be interesting to see whether this timetable is realistic. Another development which should not pass unnoticed is that under the terms of the new "Acceptance Directive" for harmonising the approval of active ingredients within the Community, provision has been made for Maximum Residue Levels to be identified at the time at which the pesticide is approved. This is a useful development in the sense that Maximum Residue Levels should be carefully considered at the time at which a pesticide is approved. MRLs identified at an early stage may need to be amended to allow for different uses in different countries who export treated produce into the Community, but at least if figures are identified and agreed at a Community level at an early stage, then the whole process of setting Community MRLs may be speeded up.

17. All Member States need to work together to solve residues problems and the same is equally true in the international sphere. Codex Alimentarius Commission discussions provide a useful starting point. Nobody wants to see another case like that of residues of procymidone in exports of Community wine to the United States. This issue focused attention on the need to resolve potential international differences because it is clear that this is an area where barriers to trade can easily exist. Efforts are now well underway to ensure that the Codex procedures for setting MRLs are as transparent as possible so that they can command widespread international support. Consumers are represented at the Commission meetings. They are also represented on the Codex Committee on Pesticide Residues. It is clearly important to ensure that any proposed MRLs have the support of consumer groups. It must be possible for the agrochemical companies and Government to be able to explain and justify any limits that are proposed so that consumers and others can support this important method of controlling the use of pesticides.

18. MRLs provide clear benchmarks against which residues in food can be assessed. They have enabled us to refuse entry into the UK for produce which contains residues in excess of our statutory limits. Two recent examples concern residues of carbaryl in Turkish Cypriot potatoes and the long running issue of residues of beta-HCH in Chinese rabbit and canned meat products. The results of Government monitoring by the Working Party on Pesticide Residues are now published annually in full. Our results enable other organisations to target their monitoring. Neither Government nor industry anywhere in the world can monitor all produce for all pesticide residues all of the time. But we can build up a picture of where residues are likely to occur and hence where resources should be targeted. The results of our monitoring are very similar to those of other countries with large scale programmes, such as the United States of America. Overall, the UK

picture shows that for fruit and vegetables and cereals and cereal products residues are likely to be present where pesticides are used post harvest or to have a post-harvest effect. This is not surprising given that such treatment is intended to preserve treated produce once it is harvested and the residue often needs to be present to achieve the effect. For animal products, persistent organochlorines are likely to be present in about a third of samples but at low levels. Overall, for 1988/89 no residues were found in 66% of samples analysed in the UK. Residues were found but below MRLs in 32% of cases and above MRLs in 2% of samples. In the United States, no residues were found in 63% of samples taken in 1990; residues were found, but below MRLs in 34% of samples; and residues were found above MRLs or where no pesticide/commodity tolerance had been set such that any residue found is considered "violative" in 3% of samples.

19. The UK Government has access not just to the results of monitoring carried out by its Working Party on Pesticide Residues. Monitoring data is published by a number of other countries. It is also intended that results should be shared amongst Member States within the Community, although we have yet to see monitoring results from some Member States. Partly following the introduction of the new Food Safety Act 1990 with its due diligence clause, and partly in response to increased public interest in this area, a considerable amount of monitoring is now carried out by retailers and others throughout the food producing chain. The Government is very grateful to those in industry who make their results available. The aim is to ensure that there are no unexpected residues arising in food. If anything unexpected occurs we would wish to investigate it immediately and to take whatever corrective steps are necessary. The protection of human health is the prime consideration. Those who use pesticides correctly should also be confident that residues in treated produce should comply with MRLs. Misuse of pesticides cannot be

tolerated. If residues are found over MRLs then clearly it is possible that misuse has taken place. It is also possible that there are other explanations. Certainly investigation is required.

20. Finally, the labelling of treated produce is an issue worthy of detailed consideration. Ministers asked the Food Advisory Committee (FAC) to consider whether treated produce should be labelled. The Committee have recommended that post-harvest treatments be labelled. Their recommendation does not require the name of the particular active ingredient to be included and it is confined to treatments applied post-harvest. This will include waxing as well as treatment with preservatives or pesticides. The FAC recommendations were widely circulated for comments. Ministers made it clear in the Government response that they were "sympathetic to the principle that consumers should have sufficient information to enable them to make an informed choice". They asked particularly for information on how the FAC recommendations could be implemented and on the practical and financial consequences for industry and consumers which would be likely to be significant. Comments were also sought on how a sensible line might be drawn between products and treatments which should be covered and those which should not and whether any pre-harvest treatments should be labelled. Neither the FAC nor Ministers have yet had a chance to consider the comments received and Ministers will certainly wish to do so most carefully before making up their minds.

21. The Food Labelling Survey commissioned during the FAC review contains some interesting statistics. When asked if there was any information not included on labels which consumers felt should be included, out of a total of 1028 people questioned, no single consumer mentioned pesticides . When prompted by a list of possible items, 50% said that they would use and refer to

information on whether pesticides had been used, 42% said that they would use information on whether food had been produced organically and 23% said they would use information on the name of the pesticide used.

22. There is no doubt that if labelling were to be introduced, and this could only be done as part of a Community programme, then there would be changes in existing practices. It is clearly important that informative labelling be provided for consumers on issues which they regard as of key interest and that they should not be misled. It is also important that the costs to all consumers are considered to be outweighed by the benefits to those who would use such labelling, and that any legislation be enforceable.

DISCUSSION

A.D. Ruthven: Although there may be some public concern regarding the Pesticide Residue Monitoring Programme, I wish to reassure the audience that they can have confidence in the results because of the built in published quality assurance checks.

F. Radcliffe: I agree with Mr. Ruthven and following the original study published in Farmers Weekly we have followed this up with two further studies involving more pesticides and additional laboratories. If you are concerned about the service you will receive from a contract analytical laboratory, ask them if they participated in the Scheme and ask to see their results. Furthermore, the results published by the Working Party on Pesticide Residues are mainly produced in Government Laboratories and there is a very tight procedure to ensure their validity before they are published.

C.R.W. Spedding: Do the published procedures detail sampling procedures?

F. Radcliffe: There is a Codex procedure defining how samples should be taken. On a further point, I think it is important to emphasise the need to determine the reasons when MRLs are exceeded.

Pesticides, consumer confidence and the challenge to corporate and government policy makers

Tim Lang, Parents for Safe Food

Paper to 'Food Quality and Crop Protection Agents' Society of Chemistry and Industry conference, London, October 8, 1991

Introduction

It may seem odd for a consumer advocate to start by expressing a concern about farmers and the land, but I make no apologies. Consumers need farmers and growers. For us, the issue is not whether to support farming but what sort of farming do we want and and how is the public to get it. Pesticides are at the heart of this contemporary debate.

Farmers are under pressure from all sides. On the one side, agrochemical manufacturers and the Ministry of Agriculture, Fisheries and Food (MAFF) reassure them that pesticides, properly handled, are safe and that the new generation of products are more environmentally benign. On the other side, consumers and defenders of the public health and the environment are demanding less or no use of pesticides.

Broadly, there are two models of food production on offer, one at each end of a continuum. One offers further intensification and a tendency to pesticide-dependent monoculture. The other heralds extensification and diversification of production. The tension between these models underlines the debate about reform of CAP.

Farming and its input industries cannot do whatever they like. For most of this century the public interest in the farming question has been fought over in the UK. Often the farming question has been addressed as an issue of free trade or protectionism. In my view, much of the sterility of the current agricultural trade debate is due to this outmoded dimension. In truth completely free trade never exists - as a myth or model perhaps, but as reality never these days. The contemporary agricultural policy debate is more about degrees of regulation than wholly free or protected trade.

For the purposes of this talk we can point to two models of regulation which span a regulatory continuum. At one end, trade is fully regulated. At the other end, there is what Hans Micklitz of the European University Institute in Florence has called 'access to market' regulation. In this, protection is

supposed to occur at source with 'caveat emptors' and minimal state interference thereafter. [1] In this approach, protection is supposed to occur at source, with minimal state interference in trade thereafter. The consumer is supposed to be protected by having fuller information.

The European 1992 process is the leading illustration of and experiment with this new regulatory approach. Unfortunately too often consumers and public interest groups are kept out of the key decision-making fora. Despite this, public pressure is an increasing factor in the debate about the future of farming. Consumerism is growing up. [2] Consumers have flexed their muscles and are becoming citizens. Involvement in world decision making about pesticides is very much in the minds of consumer organisations.

What do consumers want?

In 1989 market researchers Mintel found that 45% of consumers wanted to see a significant reduction in pesticides, with 26% wanting chemicals in agriculture completely banned. [3] A Consumers Association survey in 1989 found equally strong views. Many consumers are scandalised to find that their food contains residues at all.

In 1990 a MAFF survey asked 1,028 people what information on food labels they would use. Whether pesticides had been used on the food came second only to the quantity of the food's ingredients. One in four of the sample even wanted to know the name of the pesticide used. [4]

Are consumers over-reacting to scares and scandals in asking for more information about pesticide use? According to the latest Ministry tests published last year, pesticide residues were found in 26% of fruit and vegetables, with 6% over the Maximum Residue Level (MRL). Residues were also found in 21% of infant foods and in 47% of cereals, with 6% of the latter over MRLs. [5] As the British Medical Association said in 1990 'It is almost impossible for any member of the population to avoid daily exposure to very low levels of several different pesticides in food and water.' [6]

In this paper, I outline 13 key issues which I think people world-wide, not just in this country, want action on. Not all of these issues are of equal 'weight' to everyone. Nor would all consumer advocates - let alone other people - necessarily agree on their priorities, but there is a consensus about their relevance.

1. Labelling

With organic food costing up to two or three times pesticide-grown food the consumer spotlight is on the labelling of non-organic foods for their residues as much as on organic food for their lack of residues.

Not surprisingly the agrochemical and food processing industries are mounting a furious defence on the labelling issue. Initiatives on two kinds of labelling are needed: residues and the ingredients themselves.

i. Residues. Full and informative labelling should be the minimum that consumers in a rich society such as ours could expect. Alas, labelling in the UK as far as pesticide residues is currently only given by default. In May this year, the UK government Food Advisory Committee recommended that post-harvest treatments should be declared on the label. [7] By the middle of 1992 - a date put back by at least a year [8] - the European Commission, too, will have to decide on pesticide labelling. Its draft directive is overdue. Already, in the Netherlands and Germany, citrus fruit have to be labelled if they have been sprayed with a pesticide after harvest. [9]

The FAC report was welcome in some respects but on pesticides it was a bit confused, or perhaps there had been horse-trading over the recommendations. On the one hand it said it saw little need to label, but then recommended post-harvest labelling only.

I think residue labelling will have to come. And we don't want the kind of botch up there was over additives where the 'E' prefix, meant to indicate European Commission approval was interpreted, at least initially, by the public as a warning. Full disclosure is much better than half disclosure. We also know that education must accompany information.

ii. Products. Product labelling of pesticide products is bad enough for farmers and professional users, but is worse for amateur gardeners. Gardening Which? recently took a coach and horses through product labelling, so I refer you to that. [10] Its survey showed that labels weren't working on the whole, because some (from big and small companies alike) hindered information exchange. Of the bad labels, the Consumers Association found some which were meaningless, had incomplete description, vague instructions, and were often full of marketing hype (eg 'environment friendly') rather than useful information. Even if the purchaser wanted to choose on the basis of clear demands, product information

made a clear choice difficult if not impossible in far too many cases.

Many public interest groups think full labelling is the only sensible approach in the long-term, and we have outlined our proposals for a global P numbering scheme for the approximate 1000 active ingredients in use elsewhere. One standard number to be used on all product labels containing pesticides together with common or brand names in each country makes a lot of sense. [11] It would be good for producer, maker and end-recipient. It could also be used for residue labelling when appropriate.

2. More information and more independent science

All consumer groups have welcomed MAFF's pesticide safety review, but the review is no substitute for wider and longer-term work about pesticide safety. Much pesticide safety data is corporately derived. Already an 'unholy' alliance of green, consumer and agrochemical bodies have made strong representation to Government about testing, information and better monitoring. [12]

Take the issue of persistence. A key feature scientists look for in a post-harvest pesticide, is persistence (for it not to break down). This is the opposite of what they look for in other pesticide uses. There, in part due to environmentalists' pressure, the trend is for chemicals which break down quickly. Unlike pesticides used out in fields, post-harvest chemical residues are not reduced by the weather. No wonder the residues are found in Ministry studies.

The main safety feature looked for in post-harvest chemicals is that it should have low mammalian toxicity. What is looked for are any immediate or acute effects, rather than any long term, low level effects, yet it is the latter effects which perhaps should be of concern. If post-harvest treatment accounts for many of the residues found in food, no wonder consumers worry about the quaintly named 'cocktail effect', the synergies which could follow from the intake of a mixture of chemicals.

Perhaps the 'cocktail effect' should be researched, because that the consumer imbibes residues in tiny 'safe' amounts daily. Pesticides are the only chemicals which people encounter anywhere and everywhere.

3. Choice and affordable alternatives

Pressed on the issue of pesticides and their safety, Ministers and their officials always break into their version of the mantra of consumer choice (which so far baulks at requests for residue labelling, please note). Unfortunately, in real life the choice is on unequal footings, particularly for low income consumers.

Pesticide-free foods usually cost a lot more than their counterparts. Certainly consumer groups want the price differential between organic and non-organic food to drop, and were disturbed by the cynicism of Mr Ridley's 'rip off the consumer' advice. We are nervous about the power of retailers squeezing the tiny organic sector to death, only to turn to the public saying 'see, they couldn't take the embrace of the market.' Death by a 1000 hugs is no way to go.

The rules of the agricultural and food market are warped. They remind me a bit of the inbalance between private and public transport, where there is continued investment in a private transport system that makes less and less sense. Pesticide companies rise higher and higher to meet the start-up costs for new pesticides. I know it takes £30m or so to bring a new product to market. How much better use could be denied from those millions. Having affordable alternatives is not something the market is particularly good at delivering. Where investment is so great, the simple and cheap are fearsome rivals.

There will need to be more than the odd conversion grant here or there before equity will have been achieved in the marketplace between pesticide farming and organic farming. Vast investment, both public and private, warps the economics. What is urgently required from the Ministry is a national food and agriculture policy which alters the priorities.

Potatoes are a staple food. In Ministry residue tests, both the main post-harvest pesticides, tecnazine and thiabendazole, show up. Both are used on potatoes.

The presence of tecnazine is particularly sensitive. The World Health Organisation says it should be reviewed. The normally mild UK Advisory Committee on Pesticides (ACP) has recently warned it may get tough if there continues to be a lack of studies into the possible link between tecnazine and genetic damage.

Here is where consumers and farmers need to get their heads together. Using chemicals to stop sprouting and to inhibit disease is like taking a hammer to crack a nut. Necessary only very rarely; not routinely. The

alternative is to invest in better storage, better temperature and humidity controls on and off the farm.

4. Open decision-making

After the compliment about the ACP, now some harsh words about the membership of the ACP. If there can be consumer representatives on the Food Advisory Committee, and an environmentalist and a Trades Unionist on the Advisory Committee on Release into the Environment, the continued block on consumer and environmental representatives on the ACP is frankly getting to look a little ridiculous. A year and a half after writing to the ACP Chair on the issue, three UK Non Governmental Organisations (my own included) are still waiting for a reply. What has government to fear? The Minister replied, so why not the ACP? I thought it was independent.

Surely it would be in industry's interests, too, to have better consumer representation and to have a register of funding interests of committee members? I am sure there is nothing to hide and disclosure would help clarify the important area where private (and public) money and public work meet.

Public concern about decision-making is not only a concern about Britain's structures. Increasingly attention is moving to international circles due to 1992, the reform of the Common Agricultural Policy and the General Agreement on Tariffs and Trade (GATT). Let me consider the latter, as it interests me most.

Under the General Agreement on Tariffs and Trade (GATT) Sanitary and Phytosanitary Standards (SPS) proposals the Codex Alimentarius Commission is to be given a bigger and significant global role. In arbitration cases, for instance, Codex will be the 'above reproach' setter of scientific standards. So who sits on Codex?

The Codex Alimentarius pesticides committee, which met in April 1991, for example, had 197 participants, of which 50 were from agrochemical companies, 14 from food companies, 7 with no named or professional designation (which may or may not mean a consultant for industry), 2 public chemists and just 2 consumer representatives. The rest were civil servants. [13] Balanced?

5. Strict safety standards

It's odd how the food standards big-wigs in every rich country I visit seem to claim their region of control has the best standards. They say it in the USA, in Australia, in Canada, in the UK, in Scandinavia, in the EC. I respect their pride, but have noted a fall or two also. In general, consumer respect goes to those authorities who show a little humility.

In the negotiations over the General Agreement on Tariffs and Trade (GATT) differences in pesticide residue standards on food have become highly contentious. This spring Ralph Nader's Public Citizen organisation in the USA sent every politician a free sample of DDT to remind them that things like residue standards were at stake in the run-up to the congress vote on the Mexico-USA-Canada Free Trade Agreement.

Pesticide standards are becoming big news. Last year, Greenpeace USA did a study showing how higher US standards could be undermined if a United Nations' body, Codex Alimentarius Commission set the world standards after the new GATT was signed. [14] Levels of benomyl on carrots would worsen by 10 fold. Levels of permethrin on apples by 40 fold. Levels of lindane on strawberries by three fold. Some levels were advantageous too, but most consumers would expect harmonisation to be to the highest common denominator. If there is a problem achieving that goal, there should be support for the worst to match the best, not some game of scientific snakes and ladders.

Australia is currently setting up a new federal National Food Authority to harmonise the 6 states' standards. Preparing for this change and in the context of GATT's proposals to give more influence to Codex a study was set up to compare standards and see if Australians would do well from this harmonisation process in theory. The study suggested that out of 135 where Australian standards were at variance with international standards, 121 of those harmonisation proposals would result in a lowering of standards.

Consistently, the Australian new National Food Authority was being recommended to adopt the FAO's Codex Alimentarius Commission standard if it was lower, and vice versa being recommended to adopt the proposed new domestic standard if the international standard was higher. [15]

With findings like these is it any wonder consumer and public interest groups are getting a bit sceptical about claims that removal of barriers to trade is a good idea? It may be good for traders, but whether that is good for ordinary people is a moot point.

The ideal for both consumer confidence and public and

environmental health is to have controls at source. But who is to monitor these standards? Options include the following:

* No-one. In practice this can be presented as the 'label it' option, leaving the standard to find its own level through consumers/market forces. Market forces are strange - much eulogised by industry ideologues when they get what they want, and not otherwise. In the 1980s I noted a surprising tendency for industry to cry 'not fair' when consumers used the market to deliver a tough message! The air was suddenly thick with calls for government to act, or occasionally for round-table discussions and meetings.

* Government. On this enough has been said.

* Supermarkets. In the UK's concentrated retail sector this has looked a likely runner with Gateway, and Safeway making promising noises. This year the Co-op announced its own banding system announcing agrochemicals it approves and others it would rather not see used. I think such schemes show that retailers may be willing to move faster than Government will let them. The market - competition between and within sectors - is actually holding them back. A case for imaginative Government action, perhaps?

* International bodies, such as the Codex Alimentarius Commission. Again enough said.

Personally, I think all of the last three have something to contribute to public protection. For all options, the critical question is not whether but how? Who makes the decisions? Who chooses the members? What interests do they reflect or represent? How open are they?

6. Not to be a guinea pig

Approximately 250 pesticides out of around 450 pesticides approved for use in the UK are under review of some sort, yet they are still in use. Being under review is not, of course, equivalent to being under suspicion. Nevertheless people like myself are left feeling uneasy. Why not suspend the use of pesticides under review till the review is complete? If consumer confidence was as important as the Minister and Junior Minister implied (eg at Consumer panel meetings). What harm would be done by taking such a sensible approach? It is certainly strange to document the untrumpeted comings and goings of pesticides from the approved lists. [16]

In Greece, this March I bought some Columbian bananas from a box which said: 'Thiabendazole applied to preserve quality in transit.' Hype apart, at least the shop-keeper (if she spoke English) could be better informed. Why not share this knowledge with consumers? In Germany, citrus fruit with any post-harvest treatment such as thiabendazole have to declare it on a label. Thiabendazole is a fungicide currently under review in the UK. Foods which travel long-distances often get sprayed after picking.

Besides thiabendazole, bananas can be dipped in a suspension of maneb, an ethylene bisdithiocarbamate (EBDC) pesticide which breaks down into ethylene thiourea (ETU) which the International Agency on Research on Cancer classifies as a possible cancer-causer. [17] The US Environment Protection Agency calls it a probable cancer-causer. Maneb is under review in the UK, but is still in use. Why should consumers put up with this?

7. No circle of poisons

With global barriers to trade being dismantled, there is growing consumer concern about the circle of poisons - pesticides banned at home, being exported (despite the Food and Agriculture Organisation's Prior Informed Consent Scheme) or manufactured elsewhere and returning in the form of residues. [18]

In the United States, a Circle of Poisons Prevention Act, sponsored by Senator Leahy has gathered widescale support. Senator Leahy's Bill proposes to close the legal loophole which allows agrochemical companies to export pesticides which US government bodies consider too dangerous for domestic farm use. [19]

Used abroad, residues from these pesticides re-enter the USA as residues on food. Leahy's data suggested that 5% of US food contains illegal pesticides. This is worrying to everyone, but especially the health-conscious consumer trying to obey World Health Organisation advice to eat more fresh fruit and vegetables and less saturated fat. [20]

In the USA according to Senator Leahy's office 10.3% of imported peas have been found with illegal pesticides in the form of residues; 8.3% of pears; 8.9% of blackberries and 8.9% of cabbages. 25% of fruit consumed in the USA, for example, is imported.

Given the relentless internationalisation of the food trade, such figures are worrying. International logic and consumer self-interest coincide in the circle of poisons, but what if they don't? Does one perspective

Your family doctor? All of those? If so, with what weight and representation?

And how are mere parents to define risk? Is one playing Russian roulette? No, endless industry scientists assured the public, the risk is almost beneath contempt it is so small. If your child is the one in a million, you don't feel too happy to know the risk is small! Perceived risk is a matter for parents to judge, by shared information, not from withheld or partial information - whomever and whichever 'side' of a scientific debate it is from. The process of judgement is like justice. It has to be seen to be done, as well as actually be done.

11. No Gaddarene rush from the factory farm to the biotechnology farm

Biotechnology is waiting not so far in the wings. Already a herbicide-resistant sugar beet is on its way to market. Genetic engineering raises many consumer and ethical points. There is some feeling among many public interest groups that market forces cannot manage a technological revolution of this order. Proponents of biotechnology are wont to brush down their (historically inaccurate) notions of luddism [27] and miss the point.

Europe is currently caught in a stupid war of nerves with the USA over its biotechnology strategy and over how 'friendly' or 'unfriendly' the EC biotechnology regime is. The Agrochemical sector is already worth billions of dollars. The biotechnology promises to be. Alas, to outsiders biotechnology's investment pattern is already looking decidedly warped. The close links between seed, pesticide and biotechnology companies makes observers a little nervous. The glyphosate-resistant genetically modified sugar beet currently under trial is hardly an advertisement for the industry. The EC's draft directive on the patenting of biotechnological inventions goes too far. [28] No-one has the right to start claiming rights to public assets in this manner. As I am sure you know, there is growing resistance to this directive. Already the European Parliament's Agriculture Committee has rejected it. I sense a powerful industry about to score an own-goal.

Despite many a warning from consumer and environment groups, governments and industry seem more interested to promote each other than the public interest. With their experience of public concerns about pesticides the agrochemical giants investing in biotechnology should know better.

12. Controls on Concentration

After the Second World War, agrochemical companies mushroomed. By 1989, the world's top 20 companies accounted for 94% of world trade: 9 from Europe, 6 from the USA and 5 from Japan. [29] This is a trade in biocides, which the World Health Organisation estimates causes 3 million acute poisoning cases and 20,000 deaths or more a year. [30]

In the UK the amount of active ingredients being sprayed on the land is gradually dropping, down from 33,000 tonnes in 1983 to 29,000 tonnes in 1989, but being spread over more land: up from 15 million hectares in 1983 to 23 million in 1989. [31] Pesticide exports are rising by leaps and bounds. Eastern Europe spells a bonanza, while Africa and Latin American markets are stagnant due to financial crises.

A public enquiry either by UK Royal Commission or ideally by the European Commission into the market reach and power of companies spanning the pharmaceutical, agrochemical and biotechnology sectors is long overdue.

13. Priority to consumer confidence

There was a build-up of tension over pesticides in 1970s. There were clashes in the 1980s. The big question is will there be quiet and peace in the 1990s? My forecast is yes and no. I should make it quite clear that the public distrust of MAFF and the agrochemical industry is not the fault of the agrochemical industry alone. Consumer reaction to the UK food scandals of the mid to late 1980s surprised many people and did wrench some change out of government. The rhetoric of the free market approach was reigned in. The Food Safety Act 1990 (with following regulations) should bring genuine improvements.

Such changes have forced the food industry, with certain exceptions, to take note of consumer demands, as expressed through sales and other means. This raises an important point. Consumerism itself - the exertion of pressure in the market on behalf of purchasers - is changing. The old 'value-for-money' consumerism is taking on board newer waves of public interest: public health, the environment, ethics. In a shift reminiscent of the 19th century realisation by the middle classes fearful of industrialisation, the consumer movement is going through an internal upheaval and transmogrification. Part of this process has led consumerism to challenge aspects of industry-funded science. There is a debate within science as

well as about science and technology. There is now a battle for the public mind, as well as its heart.

Advertisements suggesting that pesticides are the bulwark against mass starvation are frankly crude to a media literate population, let alone to any student of the world food economy. People thrive, survive or starve mainly - but not solely - according to whether they have enough money to buy food. [32]

The food industry and all the industries which feed it are immensely powerful. Britain's food companies are among Europe's most powerful. They need consumers - citizens - to buy their products, but consumers are making it clear that they want industry to clean up its act, to mover faster and do more to meet them half way. The pressure for environmental, health and consumer protection is now a world-wide concern, not a little local difficulty.

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FOOD AND CHEMICALS - WHAT DO WE KNOW

G.L.P. RANDALL

ICI PLC, Group Environmental Laboratory, Freshwater Quarry, Brixham, Devon, TQ5 8BA

We are all familiar with the concerns raised about the presence of non-indigenous chemicals in food by world media on behalf of groups which claim to represent sectors of public opinion. In recent years I have had a keen interest in this area as an individual and because of my responsibilities in the Agrochemicals business of ICI PLC. In the course of my activities I have sought the basic factual data associated with the issues and have encouraged others to do the same.

SHARING INFORMATION

I, like many scientists, am shackled by the training that makes me start to understand phenomena via routes based on the detailed scientific logic derived from the accumulated information collected over many decades by thousands of scientists. This basis of understanding has, for me, been an unhelpful way of sharing the conclusions of my fellow scientists, ranging across many disciplines, with interested and concerned groups both inside the business I have worked in and in sectors of the general public. This is not exclusive to scientists: have you ever tried to understand the basis for the relative merits of fine music as expressed by professionals who operate in this area of the arts? At least they seem to speak the same language as that used in ordinary conversation. Scientists when heard via the ear of a non-scientist speak a foreign and unintelligible language! Until more recent times our non-scientist colleagues in the community have been more than willing to accept and trust the conclusions of this unintelligible information. This has led us to ignore the need to share our conclusions in clear and comprehensible ways. As trust in the integrity of science has declined it has left us with a massive communication void. One of the clearest examples of this is in the area of chemicals in our foodstuffs, an understandably emotive issue that we can be reminded about at every meal and snack time.

The purpose of this paper is to present to you the headline details of the issue. Those expecting a detailed treatise about the evaluation of the behaviour of chemicals in the food chain should read the excellent works that are available in most professional libraries.

FOOD AND PEOPLE

Let us start with the primary purpose of food, which is to stop us dying of starvation, a fact that often escapes those of us who are lucky enough to have enough wealth to corner a sector of this scarce commodity for our own exclusive use. This of course applies equally in the so-called first, second and third worlds. The developed world has an exclusive position arrived at by a combination of low population growth, industrialisation, geography and incredibly successful agriculture to give all its population enough food without the need to defend it from attack by those who starve. This apparently

robust status has shown its fragility in the food production and supply consequences of the dismantling of the Soviet Block and the USSR.

We at present have a world population of about 5 billion people to feed and by the year 2000 it is expected to grow to 6.2 billion (FAO, 1981). In the present food supply 30% would not be available if it had not been protected in growth or after harvest by chemicals introduced by man. Without their presence about 1.5 billion people would suffer from starvation, malnutrition and possible death due to the lack of food to sustain them. Our personal concern, and that of Government regulators, must be the balance between any risks presented by this use of chemicals and the inevitable death of this anonymous 1.5 billion. To do this we need look at what is done by our Governments and the industry that produces these chemicals to ensure that there is an overwhelming benefit in their use.

AGRICULTURE AND AGROCHEMICALS

It is of course necessary to put agrochemicals in their context in agriculture. In an improvement process for agriculture there is a need to address a large number of factors at once to make a sustainable improvement. They include: the use of better cropping systems and cultural practices that minimise the threats to crops from pests, diseases and weeds; the use of fertilizers and plant varieties that improve yields; in many situations plant varieties can be introduced that have higher resistance to pests and diseases whilst maintaining productive yield without introducing excessive levels of natural toxins that are harmful to *Homo sapiens*. In addition the application of irrigation and mechanisation can give sustainable improvement. The use of chemicals in addition to the use of the above does make a massive difference to the world's food supply.

ORIGIN OF AGROCHEMICALS

It is important to understand the origin of these agrochemicals. The industry produces between five and ten new active ingredients each year and these are the result of seven to ten years' R+D activity, which starts off with about 100,000 novel chemicals each year. The process of finding the products in these is a challenge that calls upon the ingenuity, intellect and hard work of a wide range of scientists, engineers and other professions. For this paper we shall concentrate on the product safety component of this selection process.

PRODUCT SAFETY

Product safety relates to the full life chain of an agrochemical from the manufacture of the active ingredient to its formulation, packaging, storage and distribution until it arrives with the farmer. Next is the handling and application to the crop, the subsequent use of that crop and, finally, disposal of the container after use. The industry addresses itself with vigour to every stage of this sequence when considering the safety of their products. Here we will look at the attention that is paid to the food use of the crop that has been treated.

KEY INFORMATION

There are four prime activities that allow us to start to assess the safety in food. They are: the toxicology of the active ingredient; its fate in the environment; its modification by the environment; and its location and presence in foodstuffs. It is important to understand the fate and modification in the environment so that potential arisings in foodstuffs from indirect routes are understood as well as the essential understanding of environmental behaviour.

The estimation of the toxicity of a chemical to man and the measurement of the quantity of that chemical in man's diet are the two prime parameters that allow regulators to assess the safety of these products in relation to our food supply.

TOXICITY TESTING

The main studies are carried out in rodents over their lifetime to assess toxicological effects and carcinogenic potential, together with other tests of teratogenic potential and reproductive effects. The objective of these tests is to use a top dose that shows an effect of the test material and a bottom dose that allows us to know at what level there is no observed adverse effect. The testing protocol is designed to show toxicity and it is thus hardly surprising that it is found and it is this component of the assessment that is seized upon by concerned groups often to the exclusion of the other valuable data, especially the dose levels and the level at which no observable adverse effect has been found.

These data are used to estimate an acceptable daily intake which can be consumed every day over a whole life span, taking into account all known facts, that will cause no harm. The margin of safety between the no observable adverse effect level (NOAEL) and the acceptable daily intake (ADI) is usually one hundred fold and can be more. The application of this safety margin to car driving would change a 30 metre braking distance (NOAEL) to one of three kilometres (ADI)!

HOW MUCH IN FOOD

It is now essential that we understand how much chemical there can be in our food. Trials are carried out to treat crops in the way that farmers do. These crops are harvested according to normal local practice. The crops are then deep frozen and shipped in the frozen state to the laboratory where the analysis is to be carried out. It should be noted that the treatment usually takes place in the country where the agrochemical company will be seeking government approval to sell the product and the analytical facility will be at a distant location. Samples are kept deep frozen in monitored freezer storage until the analysts are ready to carry out their work. This effort then produces the levels found in practice in the food commodities. In some cases processing studies will also be carried out to replicate types of use ranging from simple preparation through to, for example, the conversion of tomatoes into canned puree. The objective of this work is to give the broadest possible view of exposure.

The levels in food obtained from these studies are converted into estimates of dietary intake using World Health Organisation Guidelines which are based on total diet studies (WHO, 1989).

CHECKS AND BALANCES

There are many checks in the system to ensure the highest scientific and ethical standards are adopted in this work. The most fundamental is that of Good Laboratory Practice (GLP) which is a rigorous quality assurance system that is monitored in this country by auditors in the Department of Health. Only data produced by organisations that comply with the GLP procedures and are approved by the Department of Health are accepted by Government regulatory bodies. All the raw data on these studies are retained for inspection by the auditors. The Government have an overview of all work via their regulatory procedures which do not allow the sale of an agrochemical product unless certain information has been provided for inspection by the Government regulatory body and it has met their requirements.

In addition products are referred to an international group formed by the Food and Agriculture and World Health Organisations of the United Nations, together with Government and academic experts that they select. This group is known as the Joint Meeting on Pesticide Residues (JMPR). It takes an international perspective of agrochemical use which is independent of the agrochemical producers.

BENEFITS

I put to you that we have in the agrochemical industry a responsible group who are checked by Governments who are in turn advised by world experts. Very large safety margins are applied to data collected in a comprehensive, auditable way by the industry and that the output of this industry keeps 1.5 billion people from death by starvation at the moment and will make a valuable contribution to feeding the extra 1.2 billion people who will be with us by the year 2000.

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DISCUSSION

P.J.I. Snell: In view of the unreliability of some analytical contract laboratories, as mentioned earlier, how can a customer identify a laboratory providing accurate results?

G. Randall: The first thing to do is to check that the laboratory acts to a rigorous quality assurance programme. For example, GLP or other forms of accreditation, because these laboratories can be independently checked by other laboratories to examine and reinterpret the raw data or conduct second analyses on retained samples.

P.J.I. Snell: What steps have been taken to rectify the faults identified in the first MAFF-sponsored analytical residue study.

F. Radcliffe: The first point is that the study referred to did not include any pesticide manufacturers' laboratories but public analysts and contract laboratories, so please don't let reference to that study prejudice opinion on results from manufacturers' laboratories. The second point is that MAFF laboratories work to extremely tight quality assurance standards and any unusual result or one above an MRL is confirmed in another laboratory using a different analytical method. Following on from that first study the Food Analytical Quality Assessment Scheme was launched to enable more laboratories to test and improve their analytical procedures. You can ask any laboratory if they participated in the Scheme and ask to see their results and you can check the validity of their answers through the Secretariat in Norwich.

Role of Crop Protection Agents in Farming Systems: Protecting the Apple

Oliver Doubleday
Bax Farm, Tonge, Sittingbourne, Kent, ME9 9BU

ABSTRACT

Consumer demands and market grades necessitate production of very high quality apples. Some of the major pests and diseases which make this a difficult task and the role of crop protection agents (CPAs) are discussed. Progress is being made in addressing consumer concerns over the use of CPAs by the adoption of Integrated Pest Management (IPM). Among other things, IPM involves detailed monitoring and adoption of thresholds below which pests and pathogens may be tolerated. When needed specific as opposed to broad spectrum insecticides are used, encouraging the build up of populations of beneficial predators (e.g. *Typhlodromus pyri*) which can control various pests (e.g. *Panonychus ulmi, Aculus schlechtendali*). Further reductions in the use of CPAs can be expected as the result of improved sprayer technology, the use of adjuvants and development of on-farm weather monitoring systems coupled to disease forecasting models. In this context the importance of the "Off-Label" approval scheme for CPAs is emphasised.

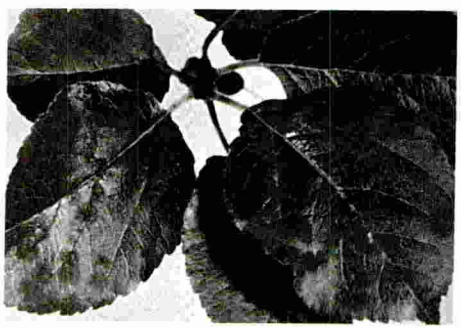
DISCUSSION

The marketing of apples within the European Community is subject to detailed Standards concerning size, shape, colour and freedom from skin blemish (1). For Class I fruit skin blemishes which do not impair the general appearance or keeping qualities are permitted for each fruit within the following limits :

elongated blemishes	-	maximum length 2 cm
other blemishes	-	maximum area 1 sq. cm with the exception of speckles (e.g., scab) which must not cover more than 0.25 sq. cm.

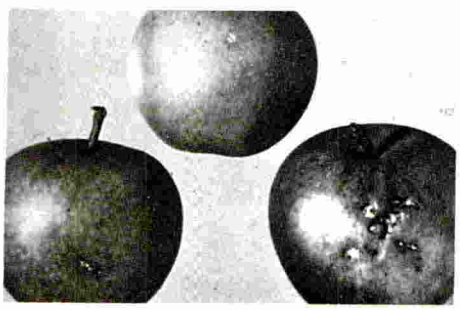
These standards, and any additional ones that may be determined by retailers and consumers, form the target which all commercial growers must seek to attain in order to obtain a reasonable return for their fruit. Apples failing to make Grade I are only saleable at a substantially reduced price. If fruit is offered for sale which does not meet the criterion for its market grade it is likely to be rejected by the MAFF market inspector. The inspector reports this failure to the grower and follows this up with a visit to the holding. If he is not satisfied that steps will be taken to avoid re-occurrence of the problem the inspector can bring legal proceedings against the grower.

Unfortunately, apples are subject to attack by many pests and diseases, which make producing Grade I fruit difficult. They are subject to damage from a number of different fungal pathogens, including scab, powdery mildew and canker. Scab (*Venturia inaequalis*) mainly over-winters on leaf debris and in wet weather spores infect both leaves and fruit, which is down-graded. Mildew (*Podosphaera leucotricha*) over-winters in buds and affects growth the following year. It is quite debilitating to trees, and even at low levels can cause substantial yield reduction. Canker (*Nectria galligena*) affects woody tissue and causes die back and fruit rot, often manifesting itself after cold storage. Insect pests include winter moth, codling and tortrix moths, aphids, red spider mites and rust mites. Rosy apple aphid (*Dysaphis plantaginae*) feeds on young leaves, causing nearby fruitlets to develop into very small, misshapen fruit. Apple grass aphid (*Rhopalosiphum insertum*) and woolly aphid (*Eriosoma lanigerum*) also damage apple trees. The larvae of codling moth (*Cydia pomella*), apple sawfly (*Hoplocampa testudinea*) and dock sawfly (*Ametastegia glabrata*) burrow into fruit rendering it unfit to eat, while the larvae of the tortrix moth (*Archips podana*) and the summer fruit tortrix moth (*Adoxophyes orana*) feed on the surface of the fruit, causing skin damage which normally results in down-grading. Similarly, the larvae of the winter moth (*Operophtera brumata*) feed on leaves and young fruitlets, leading to down-grading. Rust mites (*Aculus schlechtendali*) over-winter behind fruit buds and can cause russeting of fruit if present in high numbers early in the season. Red spider mites (*Panonychus ulmi*) over-winter as small red eggs on trees' bark. Populations can build up rapidly over the summer, causing leaves to appear bronzed. This level of infection is quite debilitating to trees. Photographs of some of these pests and diseases are shown below.

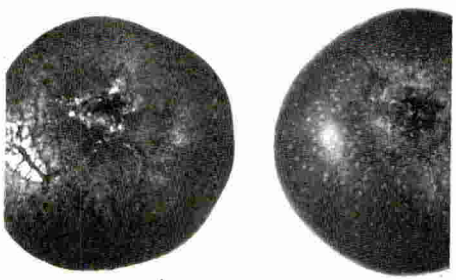


Colonies of apple scab on

Leaves **Fruit**

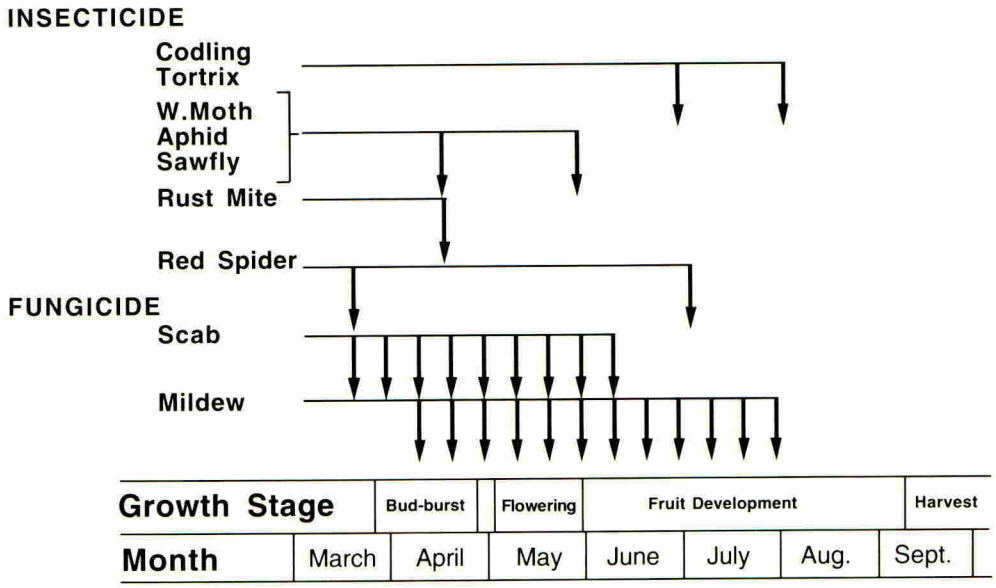


Damaged by Tortrix



Damaged by Rust Mites

A typical prophylactic spray programme which might be used to control these pests and diseases is shown below.



A typical apple orchard spray programme (after ref. 4)

The programme might well start with a red spider mite acaricidal spray, applied in late bud dormancy. Other insecticides would be applied before full bloom, to control winter moth, rust mite and aphids, and after full bloom to control sawfly, aphis and capsid. Many of the individual sprays control a range of pests. Great care is exercised during the flowering period to avoid harming bees. Later in the season further insecticides would be applied against codling, tortrix and summer fruit tortrix moths. The first of the fungicidal sprays would be applied before bloom. These sprays are intended to control scab, mildew and canker. A variety of different materials would be used, and these would be applied routinely every 7-14 days until late in the fruits' development.

Tree with mildew

Healthy tree

This Cox tree (on M9 rootstock) had a 2% incidence of mildewed leaves (on extension shoots) over 5 years.

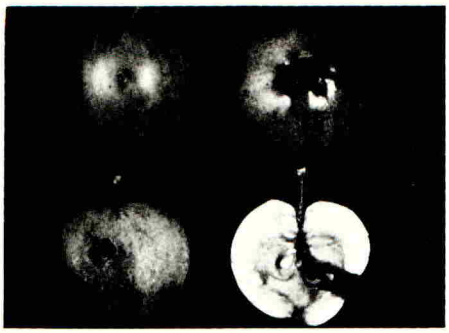
This programme is quite expensive and it may be instructive to compare the cost benefits with those achieved in other areas of agriculture. It has been shown that in England and Wales £158.7 million is spent on fungicides for winter wheat and winter barley, preventing the loss of £296.2 million, i.e. £1 spent on fungicides should return £1.85 (2). It is apparent that the cost of protecting an apple crop, which may be worth in excess of £10,000 per hectare, is in fact quite cheap.

In addition to these pests and diseases growers use herbicides, to minimise weed competition, which would otherwise reduce fruit size. They may also use growth regulators such as giberellins for a variety of objectives, such as improving fruit set (e.g. after frost damage to conference pears), improving fruit skin finish or promoting fruit bud formation and controlling tree vigour. Other sprays may include fertilisers (often urea) and minerals such as calcium chloride, which reduces deterioration in store due to "bitter pit".

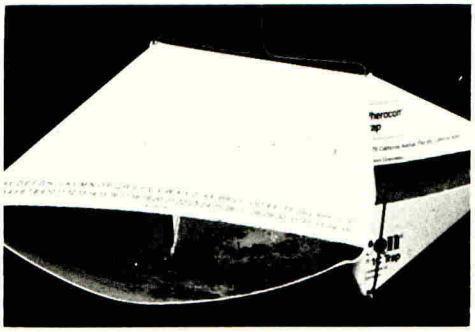
Although growers are dependent upon a wide variety of CPAs, they are aware that their consumers are becoming increasingly concerned about the use of these CPAs. A great deal of the information given to consumers has been misleading, and I personally would welcome a more informed debate, where, for example, the role of natural pesticides might also be considered (3). In spite of their scepticism of some of the claims made by pressure groups, generally growers acknowledge consumers concerns and are trying to respond to them. It is probably futile to point out that the chemicals that are used today are considerably safer than those used a generation ago, when lead arsenate was commonly used as an insecticide, and mercury as a fungicide ! An initiative has been taken by two Kent based growers cooperatives, Home Grown Fruits of Canterbury and East Kent Packers of Faversham, which together account for over 50% of the U.K. dessert apple production. In 1990 they launched GRO-ACT (growers for advanced crop treatment) among the aims of which are reductions in both the frequency and quantity of CPA applications.

Integrated Pest Management (IPM) is the system that promises the greatest reduction in use of CPAs. Solomon has published an excellent review of this subject (4), from which much of the information given here is taken. IPM involves monitoring for disease, pests and predators and deciding thresholds below which diseases and pests may be tolerated. Where control is required, strategies are evolved which minimise damage to other potentially beneficial organisms. This is often achieved by the use of products which are more specific (i.e. not broad spectrum). IPM involves careful management of the environment in and around orchards. Some weeds act as hosts for pests (e.g. dock sawfly from docks, rosy apple aphid from plantains) while hedgerow plants can be sources of pests (e.g. winter moth, from beech, oak, and wild *Prunus spp.*) and predators (*Anthocoris spp.* from alders). IPM also has implications for the planning of any future orchards plantings. Consideration should be given to the individual characteristics of a site, for example one would avoid planting Bramley trees, which are very susceptible to scab, on a site with poor air drainage, where scab might be predicted to be a problem.

Let us consider in more detail how these principles are put into practice. An elegant example of the monitoring of pests is given by codling and tortrix moths. Pheromone traps placed in orchards release a sex pheromone, and investigating male moths are trapped on a sticky surface. Counting the number of males caught over a fixed period of time gives a good indication of the moth populations, not only informing the grower when the threshold has been reached, but also providing valuable information as to the optimal timing for a insecticidal treatment.



Codling moth damage to fruit



Codling moth pheromone trap

It is clear that some forms of pest and disease damage are more "immediate" than others. For example, mildew affects tree vigour and ultimately crop weight and fruit size, but does not directly cause down-grading of fruit due to blemishes in the way that scab does. Some rough indication of thresholds for various of the common pests and diseases of apples are shown below.

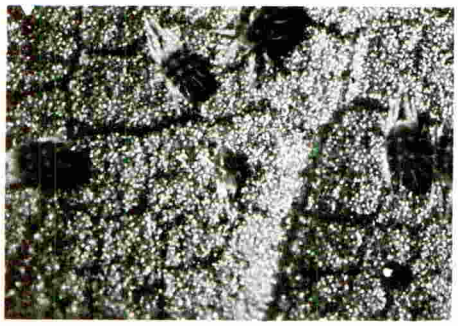
Thresholds for treatment of pests and diseases of apple

Pest/Disease	Threshold
Canker	Low
Mildew	Medium
Scab	Low
Rosy apple aphid	Low
Woolly aphid	Medium
Apple grass aphid	High
Capsid	High
Codling moth	Low
Tortrix moth	Low
Summer tortrix moth	Low
Winter moth	Low
Apple sawfly	Low
Dock sawfly	Low
Rust mite	High *
Red spider mite	High *

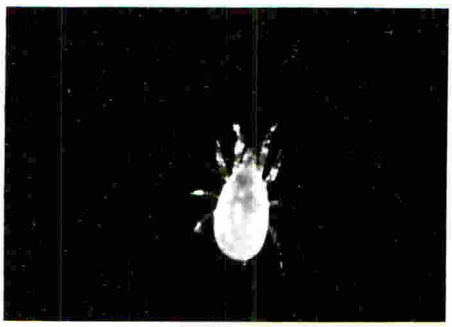
* Thresholds for rust mite and red spider mite will be influenced by the presence or absence of *Typhlodromus pyri*.

Control of the red spider mite provides an example of how the use of more specific insecticides can be helpful. The control of red spider mite has been complicated by the development of resistance to the chemicals used to control it (see 4), and the withdrawal of the most effective control, cyhexatin, in 1987 (5) increased the urgency of attempts to use other ways of controlling this pest. Although there are many predators which eat the major pests of apples including red spider mites, broad spectrum insecticides (and the insecticidal activity of some

fungicides) seldom allow their survival. However, in orchards sprayed selectively with organophosphate insecticides, avoiding the use of wide spectrum pyrethroids, populations of *Typhlodromus pyri* build up which are resistant to these organophosphates. These *Typhlodromus pyri* are capable of controlling red spider mites and rust mites.



Red spider mite *panonychus ulmi*



Typhlodromus pyri

It is interesting to note that it is difficult to envisage IPM becoming fully operational on organic farms, since the use of the highly specific insecticides and fungicides needed is not allowed in an organic system. For example, sulphur, which is widely used as a fungicide by organic growers, is toxic to *Typhlodromus pyri* (6). An example of how modern CPAs are becoming increasingly specific is afforded by the availability of commercial preparations of *Bacillus thuringiensis* to control the larvae of tortrix moths (5) and the commercial development of a granulosis virus which is absolutely specific for codling moth. One complication resulting from the use of ever more specific agents is that occasionally pests occur which have not been seen for a very long time - having been suppressed by routine treatments for many years. Examples of such pests are apple blossom weevil and apple fruit rhynchites (6).

Models predicting the spread of scab have been made and are being improved (7,8). Weather monitors measuring, for example, time, temperature and leaf wetness are also available and when combined with the scab and other disease models allow far more accurate on-farm prediction of disease risk (8). This should allow growers to reduce their prophylactic fungicide spraying, in the confidence that infection periods could be properly identified, and dealt with using curative treatments. Such a strategy would constitutes an example of Supervised Disease Control. This sort of approach to disease control would be an important component of an IPM programme.

In the long term, breeding of apple cultivars resistant to major diseases and pests is a clear objective of IPM. There is considerable diversity of sensitivity of commercially grown varieties of apples to various diseases, for example the culinary variety Bramley Seedling is very susceptible to scab, whereas Lord Derby is very resistant. The desert variety Discovery also shows an unusually high resistance to both scab and mildew.

Growers themselves are helping finance research into IPM and other important topics through the payment of a levy to the Apple and Pear Research Council. One important area of research for the Apple and Pear Research Council is into alternatives to the current practice of treating harvested fruit with fungicides and anti-oxidants in order to improve their storage qualities. This has attracted concern and criticism from some consumers, and the Food Advisory Commission has recently advised government that produce treated in this way should be labelled (9). Such labelling could clearly have an adverse effect upon the marketing of apples, and indeed other horticultural products. It is therefore important that alternatives to post harvest treatment should be found.

Over the last few years farmers and growers have faced several government initiatives aimed at increasing the safety with which CPAs are used (see 5 for a summary). The Food and Environment Protection Act (1985) and the Control of Substances Hazardous to Health regulations (1988) have both had a significant impact on both the use of CPAs and the keeping of records of usage. Growers have sought a great deal more training, often through the excellent courses run by the Agricultural Training Boards. These initiatives must have had an impact upon the safety of spray operators, the environment and food, and the public can now be assured that the regulations in the U.K. are among the most strict in the world. It is to be hoped that various interested parties will acknowledge this progress. Public confidence in the safety of food has been shaken by recent food scares. In this context it is very easy to complain about the use of CPAs, particularly in horticulture. However, it should be remembered that CPAs are being used to provide high quality food at affordable prices. Moreover, all serious commentators are agreed that horticultural products are a vital part of our diet, and that people should be encouraged to increase their consumption of fresh fruit and vegetables (10). Against this background ill-informed scares which may reduce consumption of these products seem irresponsible.

Farmers and growers have confidence in the quality and safety of their produce and welcome increased public scrutiny and interest (11). It is likely that newly developed immunoassays for specific CPAs will play an expanding role in this, since they provide a simple and inexpensive method of detecting the presence of CPAs at extremely low concentrations (12). This technology is likely to have significant impact both on food, where maximum residue levels (MRLs) have been set for a wide range of CPAs (see ref 5) and drinking water, for which maximum levels of contamination have been agreed by the European Community (13). Immunoassays could also be used within IPM since they could, for example, be used to test whether a fungicide treatment was needed for a crop for which weather monitoring had shown a disease risk (14).

If growers are to respond to concerns over residues in food and water it is essential that they should have access to the most recently developed CPAs. Growers, manufacturers and other interested parties are all extremely concerned about the delays that occur during the process of registration of new CPAs and the reviews for older CPAs. These procedures must be improved. Development of IPM would be greatly assisted if CPA manufacturers disclosed more information about their products, particularly the dose response data. For example, in Sweden CPA manufacturers are required as a part of the registration process to give information as to the efficacy of their product at reduced doses (15). Such information would be valuable to the extension services and other advisers seeking to guide growers in the reduction of CPA usage.

In addition to IPM, improvements in sprayer technology have already and will continue to allow further reductions in CPA usage, as should the use of adjuvants. Although there are likely to be some ecological benefits resulting from these reductions, insofar as they are the result of more efficient application methods, they are unlikely to significantly reduce CPA residues in food. It is worth considering that growers may actually become victims of their own success in reducing CPA usage. There are about 16,000 hectares of culinary and dessert apples grown commercially in the U.K.(16). If the average grower spends some £200 p.a. per hectare on fungicides this suggests that the total value of fungicide sales to apple growers is about £3.2 million. A substantial reduction in the amount of fungicide used by growers (some of whom have already reduced their treatment rates to 1/4 and even 1/8 of those recommended by manufacturers) would reduce the value of this market to a point where it would be difficult to envisage CPA manufacturers investing heavily in this market. Clearly the same considerations would apply to insecticides. This appears to pose a conundrum; as growers succeed in reducing their use of CPAs so they will become increasingly overlooked by manufacturers, and the development of new products may be prejudiced. For this reason it is essential that government and other interested bodies recognise the importance of the Off-Label approval scheme for CPAs. It is likely that in the future the Off-label approval scheme will play an increasingly important role in providing the diversity of high quality horticultural products, grown with a minimum of CPAs, which consumers require.

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GENERAL DISCUSSION

C. Hibbitt: One of the main concerns has been the confidence with which analytical results can be accepted. Should they all be carried out to GLP standards as conducted in pesticide manufacturers' laboratories and only results from GLP-accredited laboratories be quoted by consumer organisations?

T. Lang: The man in the street has had the right to take any food sample to a Public Analyst for analysis, particularly since the 1860 Food Act, but because of the uncertainty arising from the recent study, how can the public be certain of a quality service. What is emerging is a two division structure of Public Analysts - those in whom you can have confidence and those you cannot.

Consequently, if you do not live near an accredited laboratory, what are you to do? This is a situation where voluntary accreditation schemes or where Industry self-regulation is not good enough. What is needed from MAFF is a national scheme where laboratories are members or they are not.

F. Radcliffe: It is not true that you can have no confidence in the Public Analysts. Some laboratories may not have the appropriate expertise but they are required to redirect you. In addition, there are a number of accredited commercial laboratories that have a proven track record. A good marker would be to compare the estimated cost of an analysis with one from the MAFF laboratory at Harpenden. Furthermore, insist on two methods of analysis and that the Code of Practice published by the PPMA be adopted.

D.F. Lee: Good quality analysis can be judged by the extent of Analytical Quality Assurance (AQA) checks that accompany any result. A proper analysis may cost around £150 but the necessary AQA will cost several times this figure but this cost can be spread across a number of samples. MAFF do not publish any result found above a MRL until there has been a positive identification of the result by mass spectrometry.

C.R.W. Spedding: It does seem that there is some sound practical advice being given that should be recorded somewhere.

D. Mangold: We need to take into account, when we deal with these very low levels of residues, which can be found only by the most recent and sensitive analytical techniques, that it is difficult to interpret these results in terms of risk. So what is the value of all these data?

D.F. Lee: Yes, it is unfortunate that it can be interpreted that if a figure is quoted the consumer assumes that there is a danger. For this reason MAFF set a reporting limit, which is the MRL, and results are quoted as being above this limit. Consequently, there is frequently no quoted figure and no assumed risk.

D.L. Suett: It must be remembered that the analytical data are only as good as the sampling procedure used and the state of the sample at the time of analysis.

D.W. Bewick: On the point of identifying good analytical Contract Laboratories, in addition to selecting those with GLP accreditation, ICI conduct their own appraisal by the use of samples with known residue levels. Secondly, it is well known that data submitted for the registration of pesticides are demonstrably of high integrity. It is unfortunate that the same is not true of the adverse data we see quoted.

J. Gilmour: What is the cost of generating all these data and what is the value? Have they helped to prevent food, contaminated with a pesticide, from reaching the consumer? Can the food be analysed quickly enough in time for withdrawal if above an MRL? In view of the inordinate cost and the problems associated with monitoring food in time for withdrawal is the money being well spent or should it be used differently?

J.R. Lundehn: It is a difficult question but what will be the cost of not doing it? There is no evidence that the food in Germany is better than anywhere else in Europe. Since the BBA Scheme began we have had many discussions on the value of the monitoring programme and they continue.

D. Conning: Fear of poisoning is a very real one to the human race and consumers' organisations have managed to establish a belief, because of this fear, that pesticides can pose a threat. They have managed to undermine public confidence in scientists and the results they publish, despite the fact that we are all consumers and it is in all our best interests to protect our food. The debate we have had about measuring residues to extremely low levels by very expensive techniques has become totally irrelevant. The issue is whether you can use consumer perceptions, anxieties and fears, to establish a basis of influence and power which can control the ways in which our society works. Nobody can believe that the low levels of pesticide residues actually found can have any biological effect at all, much less an adverse effect on a consumer contacting it - the whole notion is absurd. The consumer organisations have established themselves as political bodies and will bend all these rules for their own political gain. Is this right or wrong? It is right in the sense that consumers, all of us, need to feel protected. It is wrong because the cost will be paid in human lives by starvation if the use of pesticides is stopped and this should introduce caution into our deliberations.

P. Holden: The division between consumers and the farming industry is an interesting phenomenon. The last forty years has seen increased polarisation between these two groups which has now become confrontational.

G.A. Matthews: It is welcome that farmers are adopting Integrated Pest Management (IPM) Systems as illustrated by Oliver Doubleday since this involves alternative strategies which will reduce pesticide residues. An additional welcome innovation has been the improvement in accurate application and the adoption in the U.K. of certification procedures for farm spraying.

F. Radcliffe: In addition to the MAFF residues monitoring programme the U.K. also has on-farm inspections and Ministry Codes of Practices which help to control the use of pesticides which, if used properly, will not give rise to residues above MRLs.

O. Doubleday: In relation to residue level testing farmers will use low cost immuno-assay techniques to determine whether an effective dose of, for example, fungicide remains on the crop to afford protection. IPM is going to be more difficult for the organic farmer because they cannot use compounds which are selective to beneficial insects. They are required to use broad spectrum insecticides like derris and pyrethrum. Furthermore, farmers are now better trained in the use of pesticides.

M.B. Green: Is there any evidence that pesticide residue levels in food have caused any harm? Crop protection is not a trifling problem; it is essential to use all the resources which are available to allow us to combat pests and diseases and thereby feed the world and we must all work together to this end.

B.T. Grayson: Our two residue speakers stated that some small fraction of food samples had been identified with residues above MRLs - was that a toxic hazard in any case?

J.R. Lundehn: No.

F. Radcliffe: No. MAFF's policy is to ensure that residue levels are best kept low and, if a sample is found to exceed its MRL, identify the cause.

P. Holden: Many people to-day have asked me about the yield penalty that would be associated with organic growing. In a European context there are reasons to reduce production and consequently alternative production systems should be given an opportunity. Food quality is another issue. Can the organic farmer produce an apple of the quality of conventional farming? One reason for the lack of success in this area is the level of research. Nobody has money and a vested interest in alternative methods. If the same amount of money was spent or invested in residue analysis and conventional crop production research many of these problems would be resolved.

B. Sugavanam: In developing countries the problems are different from those in developed countries in terms of the quantity and quality required. Those countries that export to the developed world have to meet their requirements and in doing so have to subsidise their cash crops and, with falling commodity prices, this has exacerbated the situation.

R.S.F. Fraser: Crop protection chemicals are a precious resource which need careful use though there are situations where there are alternatives, for example, tomatoes and peppers in glasshouse production. Here chemicals are no longer used because of resistance and also because the use of biological control systems are more effective and cheaper. It may well be that these principles could be applied to other intensive farming systems.

C.L. Berry: An earlier speaker suggested that pesticide residues would reduce the liver's ability to produce detoxifying enzymes. This is not the case, the opposite is true.

P. Snell: I have three comments from points raised earlier. Firstly, the assumption that chemical manufacturers stand the full costs of pesticide monitoring. This is not the case for pesticides in groundwater where the costs of removal are being borne by water companies. Secondly, there are examples of residues of pesticides in food stuffs causing sickness, the most notable being aldicarb in melons in the USA, albeit from an unregistered usage. Thirdly, there should not be two camps either for or against pesticide usage. It is essential that we use pesticides judiciously to avoid the rapid onset of resistance and combine them with all the weapons in our armoury to combat pest attack, as in IPM.

Anon: We have heard of problems of residues in crops and pesticides in groundwater. These are a consequence of the high rate of application. Oliver Doubleday gave examples of the success in reducing these rates. There remain opportunities to reduce these still further by improvements in formulation and application techniques.

G.K. Bruce: Reduction in application rate is of legitimate concern, which is why Government funds are being made available to examine further IPM programmes. It is also very encouraging that much of this research is in LINK associations with bodies such as the Home Grown Cereals Authority and the British Agrochemicals Association.

O. Doubleday: In my talk I asked for reduced dose efficacy data to allow the grower to determine for himself which agrochemicals can be expected to be effective, because this does not work in all situations.

B.T. Grayson: Reduced application rates can lead to the rapid development of resistance and should be approached cautiously.

O. Doubleday: There is a possible risk but there are few data and no-one has a good model but one way around it is to rotate types of pesticides.

T. Martin: The recommended dose is not just an efficaceous rate. It is a rate which will give reliable control and this is lost as rates are reduced. Consequently, it becomes very difficult to advise on lower rates of use which will give this reliability and this can never be recommended.

B.T. Grayson: In his talk David Conning stated that pesticides are, by definition, toxic. This is not the case. Many of to-day's compounds are less hazardous than substances that we spread on our food.

D. Conning: When I said toxic, I meant toxic to something, not necessarily people.

J. Gilmour: This is an important point because consumer organisations have preyed on peoples' fear of poisoning, particularly of cancer. But they have ignored the toxicity of naturally-occurring compounds with carcinogenic potential. Bruce Ames has calculated that the people of California consume 10,000 times more naturally - occurring potential carcinogens than they do from pesticide residues.

P. Riordan: We have heard to-day that there is a lack of consumer confidence in the crop protection industry. What can we do to improve consumers' confidence?

D. Conning: Firstly, education of consumers, which is a long term objective. Secondly, make available to the general public all the information that is available.

O. Doubleday: I agree - transparency and education.

J.R. Lundehn: Talk to each other, to understand the fears of the consumer and the problems of the farmer.

G.K. Bruce: Government is trying to do its best in openness and honesty in this area.

F. Radcliffe: The Government should be prepared to defend its decisions when challenged and if it cannot defend those decisions it should not be making them.

P. Holden: Transparency and diversity out of agrochemicals.

G. Randall: The target that we should aim for is the optimum use of all the technologies available.

T. Lang: I am heartened by the move to transparency and openness. That is easy to say, but we want it done.