Pesticide Policies, Practices and Initiatives - Can the UK's Know-How be Transferred to Chile?

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PESTICIDE POLICIES, PRACTICES AND INITIATIVES - CAN THE UK'S KNOW-HOW BE TRANSFERRED TO CHILE?[1]

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ABSTRACT

The dependence of farmers on pesticides to control diseases and pests is common to the developed and the developing world and is an important part of farming. In the developed world the environmental and health crisis caused by pesticides has been tackled head-on. For example, in the UK a range of policies and legislation helps ensure that the pesticides available are effective and safe if used properly. National monitoring of usage is carried out and other initiatives have helped to advise farmers on best practice, health and safety, usage minimisation and pesticide selection. The use of computers to assist with the vast amounts of data handling has contributed to the rapid progress that has been made.

In some parts of Latin America computers have also played a major role in pesticide monitoring. Packages available and in use include the VAMPP software developed by the Veterinary School of the UNA for livestock, Costa Rica and an integrated bio-economic farm level monitoring programme developed by EMRPAPA and UNICAP in Sao Paulo, Brazil.

However, in Chile the situation is very different. Little monitoring is carried out and little information is available to farmers on how to select and use pesticides. The climate does not encourage the use of protective clothing and the high cost of the newer, safer pesticides all contribute to the problem. There are frequent and widespread cases illustrating misuse of pesticides.

In the UK a major research project has developed a computerised auditing system to help farmers modify practices in order to improve their environmental performance. A significant part of this software is dedicated to pesticide use. A performance index has been developed based upon the selected pesticide, it's environmental and toxicological impact and how the farmer handles the chemicals (e.g. waste management, storage and application techniques). This system is currently being assessed by food retailers and government with the aim of using the system to help monitor and enforce pesticide best practice.

Although, due to the lack of on-farming computing facilities in developing countries, this system is not practical for farmers themselves, the system could be used, with a little modification, by government officials, extension workers and consultants to help them formulate and implement policies for pesticide use.

INTRODUCTION

In the not too distant past a major concern within agriculture and politics was our ability to adequately feed a rapidly growing global population. Today, whilst some parts of the world still face this problem, other parts are in an over supply situation. This change is largely due to the increases in agricultural production caused by intensive farming and the use of agro-chemicals i.e. fertilisers and pesticides. Whilst increased food production is obviously welcomed, these benefits have been accompanied by serious penalties for the environment, health and safety. It has been estimated that 2.5 million tonnes of pesticides are applied annually to crops world-wide but despite this we still lose about a third of agricultural crop production to pests (Pimentel, 1990). Consequently, as yet, we still depend heavily on pesticides to ensure an adequate food supply.

The developed world has taken many steps to help alleviate the problems caused by pesticide misuse. For example in the UK new research has developed safer, more selective products and only government approved products can be sold, used and advertised. Legislation covers all aspects of the pesticide industry from manufacture and sale to application and disposal. Government policy seeks to ensure that pesticides are used safely

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and efficiently and in support of this policy many initiatives to help and advise the farmer have been put in place.

In Chile the situation is very different. Many pesticides withdrawn or under restricted use in Europe and the United States of America are still widely used, for example parathion, lindane and pentachlorophenol. The higher cost of the newer, and, perhaps safer products means that they are less utilised. The climate does not encourage the use of protective clothing and in any case, it too has only a limited availability. Many problems have been caused by aerial spraying which is still commonly carried out. Problems in the Rancagua area were brought to the publics attention by the work of Dr. Victoria Mella (Mella, 1990). Dr Mella worked for a number of years in a maternity department in a hospital in Rancagua and had become concerned at the large numbers of malformed babies born in the area. Having excluded other possible causes of the problem, including excessive alcohol consumption, smoking and genetic factors, the researchers concluded that an external agent found in the Rancagua area was responsible. The common factor was that either one or both of the parents had been exposed to pesticides. The response to this report from the authorities and pesticide companies was not favourable.

Within Chilean agriculture there is little formal training available except possibly on the larger farms and no requirements for users or advisors to have certificates of competence. Anyone can buy pesticides and use them. One major problem is caused by the use of temporary workers who move from farm to farm as the work requires and therefore at harvest time there may be a very large number of temporary workers. Training and provision of protective clothing in these circumstances is not on the agenda.

This paper seeks to compare and contrast the pesticide situation in the UK and Chile and discusses how UK initiatives aimed at promoting safe practices could be transferred to Chile and to other developing countries.

THE UK SITUATION

Within the UK around 30,000 tonnes of pesticide are used annually. Between 1984 and 1994 the total tonnage of pesticide active ingredients used showed a significant decrease of over 17% or 33% if sulphuric acid is discounted. During the same period, whilst over 7% equivalent to a million hectares of agricultural land was lost from the UK, the actual application area (number of pesticides applied x number of applications x area treated ha) increased by almost 20% (Thomas, 1997) The decrease in usage has resulted mainly from a move to more complex tank mixes using newer more active products applied at reduced rates. The increase in the application area is due to an expansion of spraying programmes especially with respect to cereals (Thomas, 1997). The drop in usage goes well beyond what would be expected despite these issues. Current data suggests that the UK applies approximately 5.4 kg of active ingredient per hectare of land. This equates well with the European Union average of approximately 5.7 kg/ha (Wolf and Donnely, 1997)

UK pesticide use has changed significantly over the last decade. During the 1980's usage was much less intense. The area of crops grown during the last ten years or so has also changed quite dramatically. Almost a million hectares of cereals and over a half a million hectares of grassland have been lost. There have also been decreases in top fruit, soft fruit and hops. However, there have been an increase in oilseeds of almost 0.25 million hectares plus a smaller increase in pulses. The same period has seen the introduction of new pesticide products and the withdrawal of others. Table 1 shows the top 10 pesticides used in the UK during 1994 (Thomas, 1997) ranked in descending order of weight applied.

Table 1: Top ten UK pesticides by weight applied

	Active Ingredient	Tonnes Applied		Active Ingredient	Tonnes Applied
1	Sulphuric Acid	12,997	6	Mecoprop	957
2	Isoproturon	2,382	7	Chlorothalonil	841
3	Chlormequat	2,335	8	MCPA	724
4	Mancozeb	1,191	9	Glyphosate	606
5	Sulphur	1,113	10	Mecoprop-P	578

Policy

The Government's policy on pesticide use in the UK is simple. It aims to encourage via a variety of means, the safe, effective and minimal use of pesticides. It seeks to advocate other, safer, means of pest control including the use of farming strategies such as Integrated Crop Management which utilises the use of sustainable farming techniques (MAFF, 1996), minimising reliance on chemical inputs.

Responsibility for pesticides lies primarily with the Pesticide Safety Directorate, Ministry of Agriculture, Fisheries and Food (MAFF), but other parts of MAFF including Environmental Protection Division and other government departments such as the Department of the Environment, Transport and the Regions also have responsibilities and cross-department collaboration is common. All responsible departments give high priority to pesticide research and technology transfer of the findings.

Government advisory groups may be set up to develop and activate certain policy areas e.g. The Advisory Committee on Pesticides, who, amongst other responsibilities, introduced pesticide usage surveys and monitoring in 1965.

Another independent government advisory group, the Pesticides Forum, which includes representatives from the farming, environmental, retail and Government sectors, was established in 1996 in response to the Governments 1995 White Paper 'Rural England' and the 1996 Environment White Paper which both committed the Government to promoting the responsible use of pesticides. An action plan designed to reduce the impact of pesticides on the environment and human health was agreed by the Forum in August 1997. Recently, the Forum have commissioned studies to evaluate the feasibility of using a pesticide tax to assist the UK's minimisation policy.

Another aspect of policy receiving strong support from the UK's government is that of food safety. A new Food Standards Agency has just been announced which will increase public representation and scrutiny on food standards and help maintain high standards within the food industry. Although these plans are widely welcomed within the UK they are not without their criticisms. Most concerns are that the proposals are directed towards processes operating after produce has left the farm but many of the recent food scares in the UK (e.g. BSE, pesticide residues in fresh foods and bacterial contamination of water) all need to be tacked on farm as they all result primarily from intensive agriculture (Pesticide News, 1997).

The proposed solution to this is the Produce Assurance Schemes which are now rapidly emerging. There are several different schemes depending upon the produce type. For example, many of the UK food retailers have collaborated with the UK's National Farmers Union to develop a scheme for farmers, known as the 'Fresh Produce Assurance Scheme'. This scheme promotes the production of safe food through the progressive adoption of environmentally responsible farming and will have an independent verification system. A similar scheme for arable farmers is known as the Assured Combinable Crops Scheme. These schemes are voluntary and no premium will be paid for assured produce, however, assured produce will undoubtedly have a more stable market.

The main criticism from farmers is the annual levy which must be paid towards the schemes management and verification. Although this is relatively low at around £300-500 pounds ($400-600) coupled with the other problems currently facing UK farmers such as falling produce prices, the strength of Sterling and the BSE crisis, this extra cost is not widely welcomed as yet. However, these schemes are undoubtedly here to stay.

Legislation

Within the UK, regulatory controls relating to pesticides are strict. The main statutory instrument which aims to ensure that pesticides are safe and effective is the 1985 Food and Environmental Protection Act (FEPA). From FEPA the Control of Pesticide Regulations 1986 (COPR) and Pesticides (Maximum Residue Levels) as amended 1997 were laid down. COPR demands that new pesticides must undergo a rigorous registration and approval procedure, where the manufacturer must prove that the pesticide poses minimum risk to human health, safety and the environment. A pesticide will only gain approval if it meets strict standards including the provision of evidence to show that the potential for consumer exposure is within the Acceptable Daily Intake (ADI). ADI's may be defined as the amount of pesticide that could be consumed on a daily basis without resulting in harm. The European Union Authorisation Directive (91/414/EEC) seeks to harmonise national pesticide authorisation procedures across all EU States. As a result of this additional regulations have

been introduced, the Plant Protection Products Regulations 1995, which provide a means for plant protection products to gain approval.

The Maximum Residue Levels Regulations specify the maximum concentration of pesticide residue (MRL) likely to occur in or on foods after the pesticide has been used if the Codes of Good Practice are followed. MRL's are intended as a check to ensure that good practice guidelines are followed.

Pesticide users and their employers are required to comply with both the 1988 Control of Substances Hazardous to Health (COSHH) Regulations and the Health and Safety at Work Act 1974 enforced by the Health and Safety Executive (HSE). The regulatory control of pesticides is strengthened further by the need for pesticide advisers to hold a certificate of competence issued by the British Agrochemical Standards and Inspection Scheme (BASIS) and for operators to also undergo training and certification.

Other legislation can also be called upon with respect to pesticide pollution if necessary, for example for water pollution incidents the Water Resources Act, and the European Union Water Quality Directive 1980 (80/778/EEC) may also play a part.

Practices

Compared with many other industries, UK agricultural practices at farm level are relatively unregulated. Few control procedures are in place to regulate either the quantities of chemicals applied to the land or the application techniques used. Reliance is placed upon voluntary actions. However, any one who advisers farmers must have a BASIS qualification and annual refresher training is needed. Whilst it is possible to regulate against point source pesticide pollution, in the case of diffuse pollution this is much more difficult. The need for the agricultural industry to apply best practice is clearly apparent. There is much guidance and expertise available from a range of sources including government published codes of practice (MAFF/HSC, 1990; MAFF, 1993), suppliers and chemical companies. It can also be found in the popular farming press and on the Internet. In the last year or two a flood of guidance literature has been produced including literature produced by agricultural training institutions (BCPC and ATB-Landbase, 1996) and information on Integrated Crop Management (LEAF, 1994; BCPC and ATB-Landbase, 1995). Many of these documents are free or carry a very modest charge.

Probably the most important decisions facing farmers with respect to pesticides is the choice they make and how they apply them. On the latter issue the product label carries comprehensive instructions on application rates and gives warnings on health and safety risks. However on the issue of choice there are flaws in the UK system. Little information is given on the product label on the environmental risks. The label does alert the user to toxicological hazards i.e. it may be dangerous to bees or fish etc. but not to hazards from say leaching to groundwater or if the pesticide is slow to breakdown in the environment. This is mainly due to the complexities of the fate and transport of pesticides in the environment which in turn depend on local environmental conditions such as soil type, moisture content, temperature and the proximity of sensitive features such as surface waters. This makes it difficult to generalise the risks or the potential impacts. Nevertheless the decision of choice is the responsibility of the farmer and, in practice, this decision rarely considers environmental concerns but more likely is based upon cost, perceived efficacy and on past experiences.

Monitoring and other Initiatives

The use of pesticides by the agricultural industry is continuously surveyed and monitored by the Pesticide Usage Survey Group (PUSG). Surveys are carried out biennially on arable crops and on a four year rolling programme for other commodities. PUSG produce publicly available reports presenting best estimates of usage for the survey period.

The UK's Environment Agency is responsible for water pollution prevention activities and for identifying and prosecuting offenders. Reports are issued annually (EA, 1995 & 1996) summarising their work and findings including details of major prosecutions. The Environment Agency also regularly monitor the majority of the UK's surface waters, groundwater's, marine waters and effluent discharges for pesticides. This data is publicly available in database format.

Most of the UK's independent water companies (e.g. Southern Water Services, 1994) also monitor their drinking water resources for pesticide pollution in order to safeguard the quality of supplies, and ensure compliance with Drinking Water Quality Regulations which limit the level of pesticides in drinking water. The Drinking Water Directorate (DWI, 1991 & 1992)

produce annual reports describing compliance with UK and EU water quality standards. However, due to high analytical and manpower costs water companies do not monitor for all possible pesticides. Instead they attempt to predict what might occur by identifying what products are used at high rates locally and on soil persistence and degradation data.

Despite strong proactive policies and a stringent legislation system, pesticide poisoning of both humans and animals is not uncommon in the UK. All reported incidents are recorded and monitored. MAFF are responsible for investigating suspected animal poisonings whilst the Health and Safety Executive look at human incidents. During the year 1990/1 thirty three incidents of paraquat poisoning were recorded (Pesticide Monitoring Unit, 1993). Many of these incidents were attributed to either suicide or to household accidents. Organophosphates when used as sheep dips are reported as being responsible for several UK poisoning incidents either via inhalation of the toxic fumes or via the dermal route (Pesticide News, 1994).

In 1994 MAFF recorded 830 incidents where animals had been fatally poisoned by pesticides (MAFF, 1995). In the majority of cases misuse or abuse of pesticides was the cause of death and was often attributed to deliberate abuse in attempts to kill predators of game and livestock. These offenders are prosecuted if caught, for example a Scottish gamekeeper was fined the equivalent of £2000 ($3000) for using poisoned bait to try to kill hooded crows which he thought were responsible for threatening the estates grouse population. However, such prosecutions are not common.

From the farmers point of view the most important and useful initiatives introduced are those which boost their understanding of the problems of pesticides and their awareness of practical cost-effective solutions. Therefore access to information and the results of current research presented in layman's terms is invaluable. There are currently several UK initiatives concerned with technology transfer, for example several dedicated Internet sites for the farming community and many publications, reports and scientific bulletins on pesticides. One major initiative, known as EMA (Environmental Management for Agriculture) not only provides access to best practice know-how on pesticides but also provides a practical computer-based audit and performance assessment mechanism which allows strengths and weaknesses to be identified. This system is discussed in more details later.

THE CHILEAN SITUATION

Accurate, current data for pesticide use in Chile is not widely available. The Institute of Political Ecology state that pesticide imports more than doubled in the period 1984 to 1996, from 5,500 to 13,000 tonnes, with usage concentrated in the regions VI, VII and around the countries capital, Santiago in Region Metropolitan (RM) as shown in Figure 1. The average usage rate is given as around 1.9 kg/ha/yr however, around Santiago the usage rate is well above the national average (Repetto, 1996).

The fruit sector of Chile's agricultural industry is vitally important to the national economy and relies heavily on exports into western markets. Chilean farmers have responded to western consumer demands for high 'quality' and quantity by increasing their use of pesticides which has, in turn, contributed significantly to the large increase in national pesticide use and to the countries problems.

Organophosphate insecticides and herbicides dominate the Chilean market, a trend repeated across all of Latin America. Many of the active ingredients used are classified by the World Health Organisation (WHO) as 'extremely dangerous' e.g. parathion, paraquat, lindane and the organotin cyhexatin.

Over the last decade concerns regarding the widespread mis-use of pesticides in Chile has been growing. As already discussed, in 1993 and 1994 a significant number of congenital malformations were reported, many clustered in the Rancagua Curico region (Figure 1) . Almost all the parents of these children had been exposed to pesticides. The main exposure route is dermal. Pregnant women often continue to work in fields treated with pesticides, exposing their unborn children. The risk of excessive exposure is dramatically increased in countries such as Chile due to the lack of mechanisation: the majority of activities such as harvesting and packaging are carried out manually. In addition, the hot climate does not encourage the use of protective clothing and it is not widely and affordably available. According to a WHO report (1990) up to 30% of Latin American farmers showed evidence of organophosphate exposure as cholinesterase inhibition.

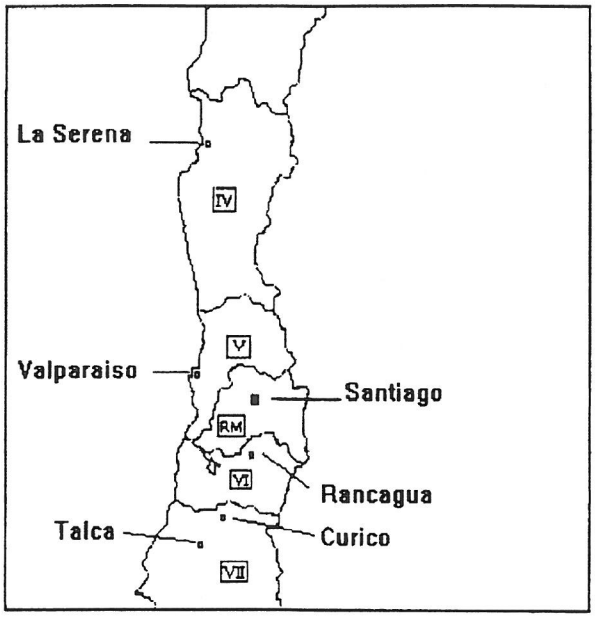

Figure 1: Map of Chile showing Santiago and Surrounding Regions

The UN Food and Agriculture Organisation estimate that there are over 100,000 tonnes of obsolete pesticides in developing countries (FAO, 1997). Chile is no exception. Environmentally sound disposal methods are not widely available and empty containers are often disposed of incorrectly or may be re-used for other purposes such as carrying water. Where usage instructions and warnings are included on the label these are not often in Spanish and, where they are, not all agricultural workers can read and understand them.

Policy

Chilean Agricultural and Health ministers have accepted that the improper use of pesticides has caused the country serious health problems and it is widely accepted that action is required. Chilean environmental groups have suggested an ecological tax on imports to finance improvements (JEMU, 1996) and they have demanded that pesticides already banned in developed countries should not be used in Chile. However, one of the main problems with this approach is that different countries have different climates, crops and pest problems, and they ban different pesticides for different reasons. For example, there are pesticides banned in USA which are still used in the UK. The big difference between these countries and for example a country such as Chile is there are restrictions imposed on the persons able to advice and use pesticides. In Chile there are no such restrictions and many workers on the farms are poorly informed as to the dangers associated with pesticide use.

Every pesticide used in Chile has to be registered with el Servico Agricola y Ganadero (SAG), and this registration involves supplying much information including details on toxicity data for humans, animals and the environment. Once the information has been supplied, the pesticide is entered on the register and can then be used. Removing a pesticide from the register seems to be more difficult and the few that have been banned appear to have been removed from the register by the pesticide supplier in response to severe adverse publicity.

Although there are laws and regulations which should help protect agricultural workers from pesticide exposure these are often poorly enforced. There appears to be no plans for introducing formal training and certification process for advisors and users, and no plans to restrict the widespread availability of pesticides. Many of the pesticide companies belong to an association called AFIPA which does seem interested in training and has also encouraged the use of triple rinsing of empty pesticide containers before disposal. In Chile, disposal of

any hazardous chemical is a problem. The first and only, facility for the disposal of hazardous chemicals has only opened in the last year. It is fairly clear from this that disposal of pesticides and their containers can be a problem. Only the large farms would have arrangements for return of containers to the pesticide company that supplied them.

Legislation

The responsibility for the regulation, restriction, prohibition, manufacture, distribution and application of pesticides within Chile lies with the SAG (Agricultural and Livestock Services). The Ministry of Health, through various departments has a role in controlling hygiene, health and security. No pesticide can be imported or manufactured in Chile without the authorisation of the Director del Servico de Salud (Director of the Health Service. Under the Code for Work legislation article 184 (Articulo 184 del Codigo del Trabajo), employers are obliged to take all necessary measures to protect effectively the life and health of workers. This has comparisons with the UK's COSHH regulations. There are also regulatory controls governing residues in food, disposal of toxic residues, environmental contamination and to limit maximum exposure and to control the period of time before re-entry into a treated area. The main interest is very much on the residues in produce for the export market. In Chile there are few laboratories testing for residues, and unlike the UK where the large supermarket chains do have sophisticated laboratory facilities, in Chile they do not exist. In reality although there are laws in place, many are not always effectively implemented.

Practices

As previously discussed many pesticides used within Chile are restricted or banned in parts of the developed world. For example, the use of pentachlorphenol in the forestry industry is common as it is effective and cheaper than any suitable, environmentally safer alternatives. Lindane is still used but mainly on cattle and in a dilute form to control head lice in humans. Cyhexatin is an organotin acaricide for which approvals for use in the UK were revoked in 1987 but is still used in Chile today.

The absence of any significant guidance available to farmers and agricultural workers on the safe use of pesticides is contributing significantly to pesticide problems in many developing countries. For Chile, a national training and awareness program is seriously needed but this alone will not be sufficient. Changes in social and cultural attitudes are also required. Increased mechanisation would undoubtedly reduce exposure but a significant capital investment would be required and social problems such as reduced employment within the sector would be experienced. If emphasis was placed on the need for individuals to have a recognised qualification before being able to advise or use pesticides, progress would be made. The problem of the large numbers of temporary workers which move from farm to farm according to the season is more difficult to resolve.

Monitoring and other Initiatives

On a national scale, no groundwater or surface water monitoring is carried nor any regular monitoring for pesticide exposure. A few isolated projects to monitor water for pesticide pollution and residues in foods have been set up. The main reasons for this include the lack of project funding and also the lack of laboratory facilities with sufficiently sophisticated equipment and technical back-up to provide continual environmental assessment. The water companies carry out some surface water monitoring, and although it seems that they should also carry out ground-water monitoring there is little evidence of this.

TRANSFERRING KNOW-HOW

Within the UK there are many separate organisations who are studying the fate and transport of pesticides in the environment and their toxicology. This obviously forms an important part of the UK's strategy on pesticides. However, equally important is the development of tools and techniques to improve the transfer of technology, information and know-how to the farm.

The EMA software discussed earlier is one major MAFF sponsored initiative which aims to support the environmental management of pesticides and to encourage more sustainable practices. The system brings together state-of-the-art information on the fate, transport, and impact on health, safety and the environment from work carried out by major researchers in the UK, Europe and the USA into practical best-practice audits for use by farmers and their

consultants. The system methodically evaluates past decisions on pesticide choice, application, and general management by applying a comprehensive set of best practice rules and so identifies how actual practices compare with best practice allowing future improvement plans to target areas most in need. Environmental performance relating to pesticide use is represented within the system by the determination of a series of numerical performance indices known as eco-ratings.

The main index is that used to reflect environmental performance with respect to pesticides applied to field crops. It is dependant upon the suitability of the pesticide for that particular site, (e.g. pesticides posing a high risk to aquatic species should not be used close to surface waters,), the environmental impact of the pesticide based upon its toxicity, physicochemical properties (e.g. solubility, vapour pressure, soil half-life) and the site conditions (e.g. soil type, local weather conditions). A second index is used to measure environmental performance with respect to pesticide management. This approach utilises a scoring technique to assess activities such as waste management, store room facilities, application techniques, equipment maintenance and calibration and use of protective clothing and equipment. The final index represents environmental performance of non-crop pesticides. This index is a compound index derived from indices for sheep dips, biocides, rodenticides, fumigants, livestock treatments, plant dips and dressings.

Descriptions of these indices have been previously published (Lewis *et al*, 1997a & 1997b). An important additional part of the system is a comprehensive information system which provides full texts of the majority of the UK's Codes of Best Practice (MAFF, 1990; MAFF/HSC 1993), summaries of legislation and library texts giving information on the agri-environment interactions. A large relational database is also accessible from the system which contains information on all aspects of pesticides including physico-chemical properties (vapour pressure, mammalian toxicity D50, solubility, soil half life etc.), FEPA approvals (i.e. crop/pest relationships where approval for use is in place), usage data such as official warnings and conditions of use, off-label uses, harvest intervals, maximum number of applications permissible and similar data for adjuvants. Data is stored by active ingredient cross-referenced to brand names.

This EMA software is proving invaluable as a source of guidance and information to farmers and their consultants as it brings together all the important information into a single, comprehensive system. The main difficulty with such a system is the need to ensure that the information and databases on which the system relies are kept up to date. Most farmers in the UK have access to a computer, either their own or their consultants and so gaining access to this software is not likely to be a problem. Currently the system is being evaluated by a major UK supermarket.

Transferring the EMA software in its current format or any similar technology to a developing country is, however, more difficult. The infra-structure of Chile's agricultural industry is considerably different from the European system. It is very unlikely that many farms would have any computer, except possibly some of the larger farms. The system is in English and relies on UK and EU legislation and in order to run the pesticide auditing evaluations record keeping is essential particularly, how much and when the pesticide was applied. In addition, the UK system, which began development in 1994, only holds information on pesticides with approvals for use from that date onwards. Consequently, any products which were withdrawn from use in the UK before 1994 do not feature in the computerised system. Some of these products may be still in use in Chile.

Despite the obvious problems the system does have enormous potential as a tool for policy makers, consultants and for agricultural colleges and institutions. Although there are areas of the software which would require a complete re-appraisal (e.g. legislation and regulation) the bulk of the information on the active ingredients remains the same as the physico-chemical properties remain the same which ever country the system is used in. Some different active ingredients will be used and the brand names will be different. Also pest types and varieties of crops grown, classification of soil type, meteorological data etc. will differ but as the system has already been developed and uses a rule-base approach, substituting rules would not be a great problem. Finally there is a need to translate the information into the language of the country it is to be used in, and this should be done by people who not only speak the language of the country but are familiar with the subject area.

CONCLUSIONS

There are significant differences between the practices and policies relating to pesticides in the UK and in Chile which have arisen, naturally over time, due to differences in local agriculture and to differences in the social, cultural and financial status of the two countries. Undoubtedly, the lessons and solutions to problems tried and tested in the developed world would be beneficial to developing counties but direct transfer is not necessarily simple.

There are many contributing factors to the problems a country has as a consequences of pesticide use. These are not unique to developing counties, and even with all the regulations, precautions and training in Europe and the USA, there are still accidents. However, the developed worlds approach has reduced these accidents substantially. The need for national training and best-practice awareness schemes together with monitoring, identification of usage patterns and the extent of pesticide pollution is clear but this will require significant capital investment and may take many years before results are seen.

A combination of many initiatives needs to be considered. The EMA system described here can ensure that accurate information is readily available and accessible to farmers in all regions of Chile. It relies on a free market situation in which there is a variety of pesticides available. To this end the farmer still makes the ultimate choice on which pesticide to use, but this is now made with knowledge and understanding of the possible negative effects of using that particular pesticide under the conditions on that farm. If, however, there are pesticides still available in the market which are cheap and effective albeit far more toxic, it is highly likely that the farmer, for economic reasons, will choose the cheaper alternative. It is for this reason that the problem needs to be tackled from more than one direction.

As a result of the lack of electronic communication facilities such as personal computers and the Internet many of the technology transfer initiatives currently proving beneficial to UK farmers will not be of use to their Chilean counterparts. However, with modification to accommodate local agricultural practices and translation into the mother language, many of the UK's initiatives could be beneficial to Chile. For example, the codes of best practice could be translated in to Spanish and distributed to Chilean farmers at a relatively modest cost. Other systems such as the EMA software could be modified to be beneficial to policy makers, consultants and for agricultural colleges and institutions.

The main problem for Chile and the other developing countries is that they, themselves, need to assess the pesticide policies, practices and initiatives that are working in the developed world in order to select those which would be most beneficial.

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