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Pesticide Management in East and Southern Africa

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Introduction

The discovery of the insecticidal nature of DDT in 1939 signaled a major breakthrough in the age-old battle against insect pests. Since then, there has been a rapid development of synthetic organic pesticides that are used to control a variety of undesirable organisms, including insects, weeds, rodents and plant diseases.

Pesticides are used for both health and agricultural purposes. In the East and Southern African countries, millions of people live under the threat of malaria, schistosomiasis, onchocerciasis, trypanosomiasis, encephalitis and a host of other diseases transmitted by insects. Agricultural losses to pest during crop production and storage can be as high as 50%. Control of pests has saved millions of lives and prevented much suffering and ill health, as well as contributed dramatically to increased food production and improved nutrition.

However, pesticides provide us with a mixed blessing. In many developing countries improper use of pesticides by untrained workers often leads to poisoning during application. By disrupting natural controls, pesticides also have a detrimental long-term impact on the environment.

Currently, developing countries use about 20% of the world's pesticide production. It appears that the use of chemical pesticides for health and agricultural purposes is a necessity that will continue for the foreseable future.

Given that pesticide use in East and Southern Africa (ESA) is going to continue, and likely will increase in the future, the Nairobi Regional Office of the United States Agency for International Development (REDSO/ESA) decided that it would be useful and timely to hold a workshop on pesticide management. This would provide an opportunity to assemble leading experts from Africa, the USA and Europe in order to discuss the issues in question.

The Regional Workshop for Pesticide Management was held in Nairobi, Kenya, from March 11th to 16th, 1985. Although the workshop was directed primarily towards East and Southern Africa, it was by no means porochial in approach.

The objectives of the workshop were:

- To evaluate the need and role of pesticides in the region;
- To stimulate a dialogue and the exchange of information among agricultural and health specialists from national governments, the chemical industry, international donor organizations, environmental groups and academia; and
- To develop a general action plan in the form of recommendations for improving pesticide management in the region.

The sessions of the workshop first undertook an evaluation of the question "are pesticides really needed in the region", then examined the current pesticide situation in selected countries. Because the chemical industry plays a key role in pesticide management in the region, industry was then invited to present its point of view. GIFAP, the international trade association of the manufacturers of agrochemicals was called on to describe its initiatives worldwide, particularly in developing countries. Next, because of the lack of adequate pesticide legislation in the region and problems associated with insufficient foreign exchange, selected countries were called on to describe how they deal with pesticide importation given these constraints. The issue of legislation (or the lack of it) was considered in depth in a separate session. Further sessions dealt with health and environmental concerns of pesticide use.

All the papers in the workshop were invited. All were presented by experts from Africa, Europe and the USA, many of whom are world-wide authorities.

After the formal presentations were made, participants were divided into working groups to address specific topics. The results of these working groups are presented here as recommendations in Annex I.

The workshop clearly demonstrated the merits of a multi-disciplinary exchange of ideas in areas of common interest. It is my sincere hope that the stimulus that was generated at the workshop will result in harmonization of efforts to improve pesticide management throughout the African region.

ACKNOWLEDGEMENTS

A workshop of this nature would not have been possible without the efforts of many of my colleagues. I would like to thank the REDSO/ESA Office in Nairobi, especially John W. Koehring and Dr. John Gaudet, for their continued enthusiasm and support for this workshop. I would also like to thank the dedicated staff at the International Centre for Insect Ecology and Physiology (ICIPE), especially Rose Washika who assisted me with the logistics, and Joy Mukanyange, who did the bulk of the technical editing for these proceedings. For funding, I am grateful to Gudren Huden from USAID's Washington Office of Foreign Disaster Assistance and to Carrol Collier from Office of the Science and Technology. Mr. Collier coordinated the funding efforts in order to get three experts from the Consortium for International Crop Protection (CICP) to participate in the workshop.

Janice Jensen
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June 1985

Welcome Remarks

by
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Mr. Chairman, honoured guests, ladies and gentlemen;

On behalf of the government and people of Kenya, I would like to take this opportunity to welcome to Kenya and more particularly to Nairobi, all foreign participants at this workshop. If this is the first time you have come to Kenya, I urge you to take a little time at the end of the workshop to visit some of the interesting parts of this country, for instance the national parks, and while at Duduville, you should feel at home.

Mr. Chairman, I understand that the main objectives of this workshop are: first, to create awareness on the use and potential problems of pesticides in the region and, secondly, to develop guidelines on such issues as safety precautions, donor activities and related aid in the form of pesticides. These objectives are broad and in my view encompass the whole complex field of pesticides and pest control including training, research and development, and the more practical aspects of pesticide utilization in agricultural production and preservation of public health.

As a subject of general discussion pesticide management, particularly in the Third World countries is topical. You are all aware of the recent Bhopal incident which occured 100 days today. Indeed it seems to me that the workshop is a special commemoration of the first 100 days of this incident. The incident has highlighted the danger that the use of pesticides poses. Notwithstanding these negative effects on non-target organisms including man and upon the environment, it is true to say that the development of pesticides is one of the most significant technological discoveries of man. It has enabled the human species to exert a greater impact on the global environment and on man's main competitors for food. In a situation like we are witnessing today; food shortages in the developing countries, particularly in sub-Saharan African countries, control of pests to reduce food losses becomes more urgent.

Pesticides today are of such fundamental importance to the human race that no responsible authority has imagined a time when their use will not be required. Indeed their use will increase with time. However, their harmful effects make it imperative to change pest control practices and to be more selective in pesticides used. If we regard them as purposive contaminants to the environment, the benefit from their use must greatly exceed any damage to environmental quality.

There is no end to the struggle against pests in our environment. We cannot hope to eradicate them. The best we can do is to co-exist with them, realizing that we and they are part of a giant ecosystem and so long as we cultivate lands we continue to invite them for competition.

Here in Kenya, our economy is heavily dependent on agriculture for the provision of food, employment and foreign exchange. Unfortunately, only less than 30% of the country is arable land at the prevailing level of technology. With a fairly rapid population growth, potential land must be fully exploited for maximum food-crop production. One of the major constraints to increased food and livestock production are pests and diseases. It is estimated that pests and diseases of crops are responsible for more than 30% yield loss in the field. Further losses in storage — due to stored product pests and fungi — are estimated at 18% of the harvested crop. This gives you a rough picture of the need to use pesticides in our agriculture. However, because of their high cost, only a limited fraction of farmers use them. Large-scale, cash-crop farmers are the main users of pesticides, estimated at about 50% of the total, while food crops receive only 20% of the pesticides used.

PESTICIDE TRADE AND INDUSTRY

In this country, we import most of the pesticides as finished products. Our import bill was estimated at US$ 21.25 million in 1983. The bulk of pesticides are fungicides, insecticides and herbicides. There are 500 pesticide formulations on the market, distributed by about 500 firms through local agents and shops. The pesticide industry in this country — and I am sure the situation is no different in other countries in the region — has been long on salesmanship and short on education. Indeed, the salesman is the key to the system. He analyses the pest problem, recommends the chemicals to be used and effects their sale. But this person is not required by law to demonstrate his professional qualifications and from what is emerging as accidental poisoning by pesticides, it is becoming necessary to start thinking of establishing categories of pesticides: those for general use, restricted use, and prescription use. Sale of pesticides in the last category should only be made by professionally qualified persons. And in order to avoid or minimize unpleasant damage to organisms other than those at which the pesticides are aimed, including man, and to the accumulation of undesirable residues, governments, manufacturers, farmers or users and their advisers should periodically come together to discuss the latest developments. It is here that we would like to commend USAID REDSO for financing this workshop. This interaction should serve a dual purpose of training and development of pesticide use strategy.

THE RESPONSIBILITY OF THE GOVERNMENT

In Kenya the government is fully aware of the benefits which are derived from the use of pesticides. It is also aware of the potential harm that the use of pesticides can do to human health and the environment. We have had a few fatal incidents resulting from misuse of pesticides. It is also known that some pests have developed resistance to some of the pesticides and this compounds the problem of pest control. Where it has been shown that certain pesticides are potentially hazardous to human health, the government has taken steps to have these withdrawn from use. The following pesticides are being considered for withdrawal from general use in this country:

Herbicide 2,4,5,-T, the neuraticide Dibromochloroprane (DBCP), and fumigant Ethylene Dibromide (EDB)

While we continue to monitor the international opinion on pesticides, through our research services, we maintain a continuous testing program on pesticides especially for efficacy in order to evolve appropriate usage.

Our capacity to evaluate pesticides has also been improved and diversified into the area of pesticide residues in food and the environment.

In order, however, that the sale and use of pesticides may be brought under strict control, the government has found it necessary to institute control by legislation.

The Pest Control Products Act, 1982, stipulates control on pesticides at all stages from manufacture, distribution and at the end use. It is therefore the desire of the Kenya government to improve pesticide management at the production and consumer level. This legislation brings into focus the need for the industry to be involved in the education of the end-users. Having said this, it still remains the responsibility of development chemists and research workers to identify pesticides that are effective with minimum disruption of the ecosystem and methods of pesticide use which involve minimum quantities to bring about the required reduction in pest population. Here, I am delighted to note that our host institution, ICIPE, are working on a strategy that not only requires minimal quantities for control of pests but would do away with chemical pesticides altogether.

The question of donor activities particularly with regard to aid in the form of pesticides, becomes important when pests like locusts, armyworm and quelea birds threaten large areas. This has been the case in the East and Southern African region in the recent past. We in this country are not yet done with armyworm infestations. In situations like this, the donor agencies have a tendency to give the pesticide that is available and not necessarily that which is appropriate, and also because of expected large-scale destruction of crops, the quick action taken to bring the pests under control results in poor formulation of the pesticides. This increases the danger to non-target organisms. We in this country have witnessed a situation that we should like to avoid in future. Suffice it to say that this workshop should come out with some guidelines as to how countries faced with destructive pests like locusts can identify pesticides that will be easily formulated and used by the small-scale farmers without endangering the lives of other animals.

Mr. Chairman, as I said earlier, this workshop could not have chosen a better theme. I am sure during your discussions you will not lose sight of the benefits which have been realized through the safe use of pesticides. You will delve into the areas which implicate pesticides and arrive at some recommendations which should improve the management of pesticides in the region. We in the Ministry of Agriculture and Livestock Development, in Kenya, will be interested in the results of this workshop.

At this point, Sir, it is my pleasure to declare the workshop officially open.

Thank you.

I.
Pesticides—are they necessary?

Thomas R. Odhiambo — Pest problems as a constraint to agriculture in tropical Africa
H.T. Reynolds — Importance of linking crop protection with crop production
H.T. Reynolds — Pesticides: A dependable component of integrated pest management programs
A. Kiss — Pesticides: How to decide

Pest Problems as a Constraint to Agriculture in Tropical Africa

by
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Agricultural production has been declining steadily in Africa in the last 15 years or so and particularly consistently in so far as food production is concerned. There are only a few exceptions in this agonizing trend: Kenya and Ivory Coast before the present decade, and Malawi ever since. Indeed, when the annual growth rate of agricultural production is juxtaposed with that of human population over the ten-year period, 1969-71 to 1977-79, it is clear that agricultural production is steadily falling behind its baseline level in the 1960's (Table 1). This trend has resulted in large food imports and sluggish agricultural development.

It is not clear why this decline should be happening at this time when in other areas of the tropical developing world Asia and Latin America agricultural production is very much on the increase, and these areas are in the middle of a "green revolution". One major factor seems to be the lack of innovative technology to support an agricultural production system which is highly dependent on rain water (Coulter, 1984). It is, indeed, the development of high-yielding crop varieties, their rapid response to irrigation, fertilizers and pesticides, and the adoption of intensive production strategies, that first ushered in the green revolution in Asia and Latin America.

TABLE 1
ANNUAL GROWTH RATE OF AGRICULTURAL PRODUCTION IN EASTERN AFRICA

Country	Agricultural production (1969-71 to 1977-79)		Annual population growth 1970-1979
	Food	Non-food	
Ethiopia	0.4	-0.8	2.1
Kenya	2.9	-7.5	3.4
Somalia	0.6	-0.8	2.3
Sudan	3.1	-3.9	2.6
Tanzania	1.9	-0.5	3.4
Uganda	1.7	-8.3	3.0

(Modified from Coulter, 1984)

Africa's dependence on rain-fed agriculture, the prevalent emphasis on expanded cultivated areas for greater productivity, the absence of such inputs as fertilizers (chemical or otherwise), and the lack of a well-articulated seed production and distribution system, all militate against improved agricultural production system. The role of crop pests (insects, weeds and diseases) in the socio-economic development of Africa more so than in other tropical regions cannot be ignored (Odhiambo, 1984).

Of the 17 recommendations advanced by the Future Actions Committee of the International Conference on Chemistry and World Food Supplies, held in Manila, Philippines, in December 1982, six of them dealt with the management of pests (Bixler and Shemlit, 1982). These recommendations were considered under the rubrics of "longer-range research at the forward edge", and "near-term R & D (research and development) related to soils, crops, pests and animal production systems" (5 recommendations). The recommendations dealt with the assigning of high priority to R & D programs in genetic engineering in relation to improved stress resistance in plants; the establishment of safety standards for pest-control agents in different environments, and the institution of international agreements covering the registration, licensing, and patent procedures for pesticides and methods; the undertaking of multiple and inter-disciplinary field studies in tropical countries to identify the factors limiting the current and optimum yield potentials; and urgent development of new chemical and biological pest control methods especially under IPM strategies.

It is not usual in a forum dealing with agricultural production for pest management to play more than an incidental role. This departure was probably due to the circumstance that the Manila Conference was concerned with agricultural production problems of the tropical developing world, where losses due to pests may be as high as 35-50%, and where, therefore, pest control is important in increased agricultural production (Bixler and Shemlit, 1982).

A special problem of Africa today is that a large proportion of its arable land is arid or semi-arid, and in many ways marginal in an agricultural production sense, particularly since irrigation is not widely used either because of a lack of tradition in this practice, or because of insufficient resources to adopt it on a large scale. The current food deficits and famine in much of the Sahelian zone and the eastern-southern regions are the results of the creeping desertification; the fragility of the soil structure which requires particular steps to continually regenerate the fertility of the soil (improved agroforestry practices, mixed cropping, crop rotation, etc.); and the lack of a knowledge base for the simple, low-cost solutions required by the resource-poor farmers who usually occupy such marginal lands. Indeed, such low-cost solutions can only be achieved through high-quality research directed towards these problems which are unique to tropical Africa.

Under these circumstances, the farmer puts a premium on reliability of crop performance

(Collinson, 1984) rather than on high yields. Traditionally, the tendency has been to rely on natural selection to single out crop varieties that resist pest attacks. Such cultivars have shown great stability in performance, as they are in balance with their total physical and biological environment (Kawano and Jennings, 1983). The secret seems to be that the plants and their pests have co-evolved over the years — the plants elaborating natural defensive chemicals, the pests responding genetically to such secondary metabolic products, and hence a dynamic balanced co-existence as a result of this chemical-genetic interplay (Feeny, 1983).

CROP GENETIC DIVERSITY AND CENTERS OF ORIGIN

The world has almost ¼ million flowering plant species — all potentially useful as food. Yet, fewer than 1,500 species have been brought into formal agriculture, and of these, 30 species now produce about 95% of global food requirements with 75% of the diet provided by only 8 crops (Nooney, 1983). The centers of origin of these cultivated plants are by and large located in the tropical and sub-tropical regions, often in mountainous zones, whereas the temperate regions became impoverished as a result of the devastating effects of the Ice Ages.

It is interesting to note that the principal production areas for the major agricultural crops are not in their centers of origin but rather outside, usually in temperate countries. The factors responsible are largely those relating to technology: the fact that the causal agents for yield losses due to pests can be more easily controlled under temperate conditions; and that whereas the temperate ecologies can sustain a cropping system with a more homogeneous genetic base, the tropical environment is such that greater genetic heterogeneity is demanded by the greater environmental stresses that operate there (Odhiambo, 1984; Kawano and Jennings, 1983).

Recent pest management research, particularly in respect of plant pathogens, has shown that in order to minimize genetic vulnerability and avoid epidemic catastrophe, cropping systems encouraging heterogeneity should be put into practice. Several examples can be given to illustrate the utility of this approach.

First, genotypes interact favourably in mixed populations of multi-lines or varieties, and increased yields of the order of 3% as well as stability in performance conferred by disease resistance are often experienced (Simmonds, 1983). Second, the procedures normally used by plant breeders to select resistance genes are frequently of the monogenic type, which has the potential of bringing to bear intense natural selection on the host-specific pathogen, thereby leading to the emergence of a new, more virulent form of the selfsame pathogen through a single-locus mutation. However, the consequence of releasing crop cultivars with a variety of resistance genes is the establishment of an unstable equilibrium to the host-specific pathogen: consequently, the respective single resistance genes that may otherwise be ineffective in monocultures may still maintain some usefulness in crop mixtures (Day et al, 1983). Third, evidence is gradually accumulating that intercropping often leads to decreased pest incidence (Odhiambo, 1979, 1984).

These and other examples point to the fact that whatever modern agricultural production systems are developed for the tropical regions, crop heterogeneity in terms of multi-lines, multi-varieties, or even inter-cropping and complex rotations, is a basic requirement in order to confer genetic stability and stable crop performance. Non-observance of this ecological principle has resulted in disease or insect epidemics. For instance, the cultivation of a single rice genotype (IR36), in an area covering 10 million ha in Asia, has resulted in an extensive epidemic of tungro virus. Similarly, intensive cereal monocultural production has increased the incidence of fungal diseases (Kotschi et al, 1983) and outbreaks of virulent biotypes of the rice brown planthopper.

Africa is fortunate that it has several centers of genetic diversity for grain legumes, cereals, bananas and forage crops. Yet, Africa is not among the leading regions in the matter of collecting and storing this important resource (Table 2). Indeed, there is a decided concentration of these gene banks in the North (Table 3). The new varieties being tested for overcoming environmental constraints (salt tolerance, greater performance under high-temperature conditions, pest resistance, etc.) are being scientifically engineered to meet these adverse factors as well as to conform to certain end-use requirements (machine harvesting, milling, baking...), and the tropics need to have a diverse genetic back-up to sustain this continuing effort. The danger is that the control of these genetic resources has rapidly become a matter for commercial rivalry, patent protection and political questioning.

TABLE 2
LEADING GERMPLASM HOLDERS

State and Institution	% of total
United States of America	22
Soviet Union	7
India	6
Malaysia	6
United Kingdom	4
IRRI	4
China	3
ICRISAT	3
Total	55

(Modified from Mooney, 1983)

In many cases where these newly engineered crop varieties have been extensively cultivated, the pest condition has been aggravated. For example, previously insignificant pests of rice in South-East Asia have become very important, for instance, the whorl maggot, the brown planthopper, the white-backed planthoppers, and leaf folder (Lim and Heong, 1984). Under these circumstances, insecticides seem to offer the most immediate solution, because of their apparent simplicity in use and effectiveness (at least in the short-run), their flexibility and their economy.

TABLE 3
GENE DRAIN OF PLANT GENETIC RESOURCES TO THE NORTH

Grouping of states	% control of collected germplasm	
North		
Industrialized market-economy states	41	55
Industrialized centrally-planned states	14	
South		
Group of 77 countries	28	31
People's China	3	
International agricultural research centers		14

(After Mooney, 1983)

THE LIMITATIONS OF INSECTICIDE USE

But simplicity in the use of insecticide has, in the end, proved a mirage. On a global scale, we have used enormous quantities of insecticides to attempt to exterminate crop pests and disease vectors over the last 40 years. The cumulative production of DDT alone reached more than 2.7 billion kilograms by 1980, and toxaphene more than 1 billion kilograms by the same time (Metcalf, 1984). Yet, as Pickett (1984) says so graphically, ". . . while we can now control almost any specific pest (with insecticides) . . . nevertheless the problem of controlling pests is more acute than ever." Consequently, though we may be winning particular insecticidal skirmishes, we are not in fact winning the major battles.

One major reason for this rather gloomy prognosis is that pest resistance to insecticides has become a "distinct threat to continuous and profitable crop production throughout the world" (Metcalf, 1984). Metcalf has suggested four measures to counter this threat:

First, to monitor insect pest populations so that endogenous susceptibility levels are understood. The same monitoring process will permit early detection of specific resistance.

Second, to avoid the use of insecticide mixtures, as they usually lead to the simultaneous development of resistance to these insecticides.

Third, to extend the useful life of an insecticide by replacing it before control fails through the development of resistance.

Fourth, to choose a sequence of suitable alternative insecticides based on genetic considerations of cross resistance and multiple resistance, by first using an insecticide with a simple one-factor resistance and limited cross resistance (e.g. malathion), by avoiding insecticides with multiple resistance (e.g. diazinon), and by changing insecticides before resistance develops.

As it happens, once selected, genes for insecticide resistance have virtually limitless persistence in wild populations (Metcalf, 1984). These counter-measures need to be incorporated in any effective insecticide management program as there are not many new insecticides coming into the market. During the period 1976-1983, only 29 new insecticides were registered in the United States of America, 9 of which were of the conventional type (Dover & Croft, 1984). Indeed, the pace of insecticide development has considerably slackened (Table 4).

TABLE 4
RATE OF DEVELOPMENT OF INSECTICIDE-RESISTANT INSECT SPECIES THROUGHOUT THE WORLD

Class of insecticide	Average doubling time (in years)
DDT Methoxyclor	6.3
Lindane Cyclodienes	5.0
Organophosphates	4.0
Carbamates	2.5
Pyrethroids	1.0

(After Metcalf, 1984)

Resistance is not the only major problem the use of insecticides may lead to: insecticides are usually more damaging to the predatory insect species than they may be to the target pests. This may come about in three ways. Firstly, the predators may be poisoned by feeding on poisoned prey, or be directly affected by the insecticide application. Secondly, because predator populations are usually less numerous than their target prey, they have less genetic material from which to develop resistance to the applied insecticide, and they take longer to regain their original population level after insecticide application. Thirdly, the predator population may be eliminated through the loss of their normal food (if the prey population becomes rare or depleted).

It is clear then, that insecticides are not the final answer to insect pests. Integrated pest management strategies seem to offer a longer-range outcome.

INTEGRATED PEST MANAGEMENT

A major factor in pest management usually only superficially considered by insect scientists is the central role of the host-plant. Insect pest management technologies have, conventionally, been insect oriented; indeed, the advent of synthetic insecticides has exacerbated this orientation. The concentration is on the mortality and morbidity of the resident insects rather than on the responses of the host-plant to the insects feeding on or ovipositing on them, and the time horizon required for such responses to have an effect on the overall productivity of the plant. What seems to be gradually becoming evident as a more effective approach to insect pest management, is to adopt a systems approach to the interactive plant host-insect relationships, in which the plant provides the principal reference point. It is only on this understanding, and the need to stabilize the crop production system by assuring genetic diversity, that a viable integrated pest management system (IPM) can effectively be established.

The following components seem to have the best potentials for crop protection in the tropics:

Varietal resistance, which is regarded as the basis of any IPM system for the resource-poor farmer.

Chemical control, which has served agriculture well when used selectively and discriminatively as "curative" intervention, but has often caused major problems when used as a continuing "preventive" measure. Chemical pesticides are usually expensive to subsistence farmers, while, it has been argued, natural products may well prove a cheap and convenient source for the farmer.

Cultural control, comprising elements such as intercropping, rotation, timely planting to escape pest infestation, and avoidance of excessive use of nitrogen fertilizers.

Manipulation of insect behavior, in relation to the host-plant, is relatively new approach, and embraces such possibilities as diverting insects to trap crops (of no economic value).

Biological control, by the use of the parasites and pathogens of the target pests or genetic mechanisms (lethal genes, sterility factors, etc.).

The various tactics employed under the various headings above are too numerous to describe here, but suffice it to say that whereas the first two approaches (varietal control and chemical control) are hampered by short-term durability under normal circumstances, the other three are complex systems requiring a great deal of basic ecological, physiological and agronomic information before a stable and durable system can emerge.

It is clear, from the resurgence of interest in the last three approaches, that we may expect significant advances in their use in the tropics in the future. For instance, intercropping has long been considered a backward form of farming, yet, many intercrop combinations can significantly reduce the incidence of certain pest problems, as in the case of the maize-groundnut dicrop wherein the incidence of the maize borer, *Ostrinia furnacalis*, is greatly reduced in the Philippines (Fordham, 1983). In China, *Trichogramma* egg parasites are being produced in rural and commune factories, utilizing eggs of the larger silk-moths (e.g. eri-silkworm, *Samia cynthia ricini*, or oak silkworm, *Antheraea pernyi*), for the control of several major lepidopterous pests of rice (e.g. *Chilo suppresalis*), cotton (e.g. *Heliothis armigera*), and sugarcane (e.g. *Diatraea venosata*). Such biological control procedures have been extended by using a hyperparasite *(Brucon greeni)*, introduced in Hainan Island, to control a parasitoid, *(Euhlemma amahilis)*, of a commercially useful insect (the lack insect, *Laccifera lacca*), (Pu Chih-Lung, 1978).

SOME EXPERIMENTAL IPM COMPONENTS

The general interest in pesticides with easily biodegradable characteristics and considerable selectivity is being met, to some extent, by the exploration of natural products having pesticidal activity. Perhaps, some of the most exciting of these belong to that group of pesticides of microbial origin. The most extensive series of these have originated from Japanese work, and include such potent agricultural antibiotics as Blasticidin S, Validmycin A, and Polyoxins (Table 5). For example, Tetranactin, which is derived from *Streptomyces*, has low toxicity to mammals, shows no phytotoxicity, and exerts its anti-mite activity only in the presence of water in such a way that this pheaomenon leads to the leakage of important ions, such as K^+. Although these microbial agents are potent anti-pest biochemicals, they easily evoke the emergence of resistant strains because of their site-specific nature (Misato and Yamaguchi, 1984).

TABLE 5
PESTICIDES OF MICROBIAL ORIGIN USED IN AGRICULTURE: JAPAN, 1984

Substance	Effective against
Insecticidal	
Tetranactin	Mites of fruit trees and tea plants
Anti-fungal	
Blasticidin S	Rice blast
Kasugamycin	Rice blast
Polyoxins	Rice sheath blight; fungal diseases of fruit trees and vegetables
Validamycins	Rice sheath blight
Mildiomycin	Powdery mildew
Anti-bacterial	
Streptomycin	Bacterial diseases of fruit trees and vegetables
Oxytetracyclin	
Novobiocin	Bacterial canker of tomato

(Misato and Yamaguchi, 1984)

Bacillus thuringiensis has been available for commercial use against plant pests (as well as certain insect vectors of human diseases such as mosquitoes and *Simulium*) since the 1950s. It does this by the production of several toxins, which directly affect specific insect groups. An exciting new possibility has recently been opened up by the isolation of the gene responsible for protein toxin production in *B. thuringiensis* and cloning it in another bacterium, *Escherichia coli* (Schnepf and Whiteley, 1981). This step could make it possible to transfer the toxin-producing gene into plants and so enable us to test whether the latter can make the toxin *in situ* for direct insect control. Such a procedure would be an improvement on simply using the toxin, and applying it, as a biological pesticide.

The old technique of tissue culture has recently inaugurated a new method of selecting for resistance against a variety of environmental factors (high or low temperature, high salinity, drought, herbicides, etc.) in an extremely rapid manner, accelerating the process several million times by providing the capacity to expose millions (or even billions) of single cells to these factors (Nowak and Lawson, 1983). Thus, by

employing this callus tissue culture procedure, and utilizing selected cell cultures, plant breeders have been able to develop sugarcane cultivars resistant to *Helminthosporium sacchari*, *Sclerospora sacchari*, and sugarcane mosaic virus, employing the ability of single cells to regenerate into complete plants after selective screening of the single cells exposed to various factors under test. Similarly, promising potato and tobacco plants, resistant to *Phytophthora*, have been selected within 2 years using this callus tissue culture method, in contrast to the 6 years the conventional F2 selection methodology carried out in greenhouses and on the field would normally have taken (Nowak and Lawson, 1983).

The last observation to be given concerns the experimental use of viruses (Table 6), particularly the highly insect-specific baculoviruses, for the control of lepidopterous insects, which contain a major group of crop pests in the tropics. Baculoviruses are restricted largely to Lepidoptera, Hymenoptera and Diptera; as they variously produce polyhedral and capsular inclusion bodies, they appear ideal biological pesticides. Their safety has been positively evaluated by the U.S. Environmental Protection Agency, a body which has established some of the most stringent standards of environmental impact assessment. The prospects for using baculoviruses for crop protection are therefore high (Benz, 1983). Already, of the 300 baculoviruses known, 50 have been produced in amounts sufficient for field testing, and 6 of these are being produced by industry: nuclear polyhedrosis viruses of 6 noctuid moths (*Autographa californica*, *Heliothis zea*, *Prodenia litura*, *Spodoptera exigua*, and *Trichoplusia ni*) and 1 sawfly forest pest, *Neodiprion sertifer*, (Benz, 1983). For regular use to be assured, three problems need to be solved. First, better persistence in the field needs to be guaranteed, perhaps through chemical protection or by genetic selection, as the virus particles are quickly inactivated by sunlight, especially ultraviolet radiation. Secondly, immediacy of impact on virus application is lacking: insect damage to crops is not immediately prevented in the first generation, although protection against future insect generations is usually good. Finally, multiple application is not adequate to trigger off an epizootic, nor to provoke a self-sustaining infection above the critical level needed for effective insect control.

TABLE 6
VIRUSES IN LARGE-SCALE USE FOR INSECT PEST CONTROL IN CROP PRODUCTION

Pest	Crop attacked	Pathogen used	Country
Heliothis zea, *H. virescens*	Cotton	NPV	USA
Heliothis armigera, *H. punctigera*	Cotton, sorghum	NPV	Australia, China
Trichoplusia ni	Cotton	NPV	Colombia, S. America
Oryctes spp	Coconut	CPV	Samoa
Spodoptera spp	Vegetables, cotton, etc.	NPV	China
Mythimna separata	Cotton	NPV	China
Agrotis segetum	Cereals, etc.	GV	Pakistan, Denmark

RESEARCH AND INNOVATION

Innovative research directed to agriculture in tropical Africa seems to be a key element in any strategy to boost agricultural production on a sustained basis. The Eastern African countries are already spending considerable sums of money on agricultural research: US$14.2 million in Kenya, $9.6 million in Sudan, and $4.8 million in Tanzania (Coulter, 1984). The number of professional scientists is substantial (Table 7). Certainly both resources should be increased considerably; but it is paramount at the same time to consider ways of using these resources more effectively.

TABLE 7
AGRICULTURAL RESEARCH EXPENDITURE AND MANPOWER IN EASTERN AFRICA, 1980

Country	Expenditure as % agricultural GPD	Number of scientists
Kenya	1.08	400
Sudan	0.57	212
Tanzania	0.35	256

(After Coulter, 1984)

We should focus more on the orientation of the research itself: to the problem-areas of peculiar relevance to Africa — those of stability of production under rain-fed farming, of developing tolerances to environmental stress, and of pests as a major threat to agriculture. But where are the innovators?

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DISCUSSIONS

Q. (Osman): How can we be sure that microbial agents will, in future, following high usage, not produce undesirable side effects similar or worse than those due to chemical pesticides today?

A. (Odhiambo): Insects have a tremendous capacity to adapt to new situations. The IPM concept recognizes this and involves the adoption of new strategies as problems of usage of one method or other are identified.

Importance of Linking Crop Protection with Crop Production

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Successful crop production has always involved a series of carefully planned actions. These actions include many considerations — date of planting, source of strong seed, produce disposal as a food or a cash crop, production needs in weeding, managing pests, irrigating, fertilizing, and many more. But plant protection is an enormously important factor in successful crop production. Few people appreciate the importance of pest-induced losses, nor do they understand the complexities of pest problems. This paper discusses some of the reasons why plant protection and production must advance in tandem. It has been variously demonstrated in many regions of the world that changes, including improvements, in plant production can be largely lost or negated entirely by lack of careful evaluation to identify needed modifications in plant protection practices.

LOSSES CAUSED BY PESTS

It should be recognized that total losses caused by pests are poorly documented; in fact, more than likely, there is no accurate way to document them. According to FAO (1983) and many other sources, pre-harvest crop losses due to weed infestations, plant diseases, arthropods (largely insects and mites), and vertebrate pests (rodents and birds) were estimated to be approximately 30 to 35%. Post-harvest losses (grain storage, etc.) amounted to an additional 10-20%. These are good estimates, but it totals to losses each year of about 40 to 50%, which is intolerable. Small losses often are never noticed, even by the farmer, but multiplied over vast areas, they can be enormous. Total losses can be exemplified best by swarms of locusts or weaver birds in a millet field, or perhaps by a plant disease epidemic. You are all aware that weeds may limit the amount of land that a subsistence farmer and his family can manage to little more than a hectare or two in many parts of the world.

We can do very little to control crop losses due to weather, but we can for those caused by pests. It was estimated by the U.S. National Academy of Science (1977) that only a 20% reduction in losses caused by pests attacking major food crops would provide food each year for 476 million additional people. This additional amount would make up most of the shortfall in food needed annually, except in areas hard hit by bad weather such as drought. Many authorities, it should be added, feel that a 50% reduction in pest losses is not an unrealistic goal.

Social, economic and humanitarian concerns all point to the need for increased food production in the developing countries. The principle ways of boosting food production are by expanding the cropped area and/or increasing yields. It has been estimated that we need to increase food production an average of 2.5% per year to meet the steadily rising food needs of the developing countries. The amount of new land brought under cultivation, although important, is not expected to exceed an average of 1% per year. Increasing crop yields, therefore, has become the main source of growth (Mellor and Adams, 1984).

There are several assumptions we can make regarding the future. As pointed out by E.H. Glass in a recent address, we are not infallible in predicting the future, but there are several developments generally accepted as inevitable during the next several decades:

Human population will continue to increase dramatically.

Demands for food and fiber will increase at a corresponding or even greater rate than populations as developing countries improve their economies and diets.

Arable lands are already very extensively used for agriculture in many parts of the world and other sources of food, such as the oceans, appear to have finite food-producing capabilities.

Much of the increased requirements for food and fiber will of necessity be met by intensified agriculture, that is, greater production per unit area.

Intensification of agriculture will create increased pest problems during production. Protection problems during storage and transportation of foods are also expected to increase as production expands in the tropics.

Demand for and use of pesticides will continue to increase.

We have already discussed the first four of these assumptions, but when agriculture is intensified, the ecology within the crop system is changed. This affects the fauna and flora associated with that crop; pest problems change and frequently intensify too.

The tools of intensified agriculture are many and frequently interact. They include high-yield cultivars, high fertility, irrigation, monocropping, continuous cropping, dense plant stands, herbicides, insecticides and more. Intensification has frequently resulted in phenomenal increases in crop yields. But, as mentioned above, pest problems are frequently aggravated. Examples have been documented for several areas of the world, especially in the U.S. (Horsfall, 1972; Reynolds, 1971; Smith, 1972). However, some of the most dramatic examples have recently occurred in the "green revolution" in rice production in Asia. Changing from one crop per year during the monsoon season, with the land lying fallow for six or more months during the dry season, to irrigated continuous cropping has greatly intensified stem borer, plant hopper, gall midge, and other insect problems. In the Philippines, a formerly undescribed species, the rice whorl maggot, has developed into a pest which reduces yields as much as 25% when uncontrolled in areas where rice is grown continuously throughout the year (Ferino, 1968a; 1968b). Thus, where rice is grown continuously, and especially where

crops in all stages of development are present throughout the year, extensive use of insecticides had become necessary to prevent heavy losses (Pathak, 1967).

Again, using rice as an example, it has been demonstrated that crops traditionally grown by farmers for long periods of time, have often developed a degree of tolerance, sometimes resistance, to certain pests. The first high-yielding rice varieties developed at IRRI, for example, were planted in many areas of South-East Asia. It was soon evident that they suffered attack by certain pests to a much greater extent than the native varieties. Plant breeding programs were able in many cases to breed the resistance factors into the improved yielding varieties.

Cotton has a pigment called gossypol, produced in small lysigenous glands in all parts of the plant except the roots. The pigment is toxic to all non-ruminant animals and must be removed from the edible cotton seed oil. For this reason, cotton plant breeders developed varieties with very low gossypol content. It was soon found that these plants were more susceptible to certain pests than high-gossypol cottons (Reynolds et al., 1982). These authors also pointed out that any modification in prevailing production practices may create changes, sometimes subtle, in the plant and in the environment.

The attractiveness and suitability of the plant and the environment to the pests (and their natural enemies) may be altered and, in some instances, this may aggravate or ameliorate certain pest problems or even create new ones. Modifications in time of application and amounts of irrigation water or fertilizer, use of different varieties, plant and row spacing, cultivation practices, or time of planting or crop maturity may all have an impact on pest or beneficial species populations. Some modifications are designed to give cultural control of a pest and may provide the first line of defense of certain species. Other control measures, such as insecticides, are only supplementary.

Cotton growers in irrigated areas have long recognized that lush spots in the field are especially attractive to certain plant bugs; *Heliothis* (boll worm) complex of species, and boll weevils. Similarly, over-irrigation and over-fertilization may produce lush plants which may not produce a larger crop but create a more severe pest problem. Other changes in production practices may also have similar far-reaching effects.

In conclusion, I must emphasize that plant protection and production must go hand in hand. One must include the other.

Increasingly in the U.S., for example, we are putting the protection and production specialists into teams to solve the common problem. A great deal of adaptive research is going to be needed in the developing countries. We cannot transfer technology, for example, from temperate climates to hot, tropical areas directly. Sharing of information developed in one country with its neighbors should be stressed, as resources are insufficient for a single country to solve all the plant protection problems. We call this "networking", and practise it both informally and in the more formal meetings of our professional societies. Trained personnel at all levels are needed, ranging from the extremely important extension officer at the farmer level to the more intensively trained research and administrative officer. In general, the countries investing a larger share of their national budget in agriculture have advanced the most rapidly as, in addition to the cash crops, more attention is given to the basic food crops (Mellor and Adams, 1984). These authors identify the African countries, where per capita food production is declining, as being in particular need of agricultural investment.

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DISCUSSIONS

Q. (Khamala): The IPM concept has been developed mainly in the USA where farms are large and farmers can afford the high labour inputs that IPM requires. How can we adapt IPM to suit farmers in the ESA?

A. (Reynolds): IPM is not very sophisticated, but it requires research. It is the responsibility of researchers in the ESA region to adapt IPM concepts to their situation.

Comment (Odhiambo): It is important that research findings be translated into what the farmer can easily use, emphasizing mainly the qualitative rather than the quantitative aspects. This multi-disciplinary approach involves the farmers themselves, economists, agronomists, social scientists as well as entomologists, and we think that this is the best approach.

Q. (El-Sebae): To what extent have U.S. farmers accepted IPM as an economically viable pest control strategy, and how can we convince our local farmers also to adopt it?

A. (Reynolds): IPM is not yet sold to all farmers in the U.S. What is important, however, is the change of philosophy amongst the farmers. Whereas they previously were not bothered about other creatures, they now love to see some wildlife such as insects and birds on their farms. Attitudes are changing in the U.S., however slowly, and that is promising for the future of IPM there.

Pesticides: A Dependable Component of Integrated Pest Management Programs

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This world needs food and it should be able to depend, year after year, upon adequate food and fiber that only a stable crop production can supply. Many countries have neither an adequate nor a stable agricultural production system: malnutrition and a host of other health and social problems result. Stable production of agricultural products depends upon many things, but plant protection from pests is a very critical one.

Pest numbers are legion and may take many forms — birds, insects, mites, nematodes, weeds, plant diseases, rodents, and many more. Man has always sought means to cope with pest-induced problems affecting his health, comfort, esthetic values and freedom from annoyance. Protecting domestic animals, crops, forests, and other property is also very important.

Insect problems are not unique to modern civilization. Graphic accounts of insect attack are found in literature of the ancient Chinese, Egyptian, Greek and other civilizations. Some, such as the flea, body louse, and desert locust, can be identified in the ancient writings.

Early attempts to cope with pest problems were largely ineffective, at best feeble, and man had been forced to share his abode, body and food supply. In relatively recent years, however, advances in our knowledge of pest habits and life history and a rapidly advancing technology have given man reasonably effective means of protection.

Concentrated efforts to control a variety of organisms largely began with the development of agriculture and permanent settlements about 10,000 years ago. Early efforts were poor, some dealing with mysticism, but gradually a few chemicals were discovered, sulfur, for example, with moderate to good effectiveness on certain pests. In the early 1900s, pest control was still grossly inadequate and losses to pests were consistent and even at times catastrophic.

In the mid-1940's, the first synthetic organic pesticides began to appear, beginning with DDT, BHC and 2, 4-D. These, plus those which soon followed, opened a new era in pest control. For the first time, entomologists were able to reduce quantity and quality losses to many insect species. In the United States, crop yields increased over 50%. Not all of this increase can be attributed to new pesticides, of course, but they are a factor and added a stability to agricultural production never before possible.

Integrated pest management or integrated pest control, as it is sometimes termed, (IPM or IPC, respectively), is an ecological approach which attempts to coordinate use of multiple tactics in a single integrated system. A key term in this is the "multiple tactics" or techniques. Later in this presentation, "coordinate" will be discussed also. It has been demonstrated time and time again throughout world agriculture that total dependence upon any single control or management tactic will fail at times — sometimes with devastating losses in agricultural production. This holds true whether the sole reliance be on natural enemies, insecticides, sterile insect release methods, cultural control, or any other techniques. Our IPM goal is to hold pest numbers and damage to acceptable levels; it is a containment rather than an eradication strategy.

There has been much adverse publicity in some countries, e.g. the United States, about misuse, overuse and occasionally even any use of pesticides. Yet they remain the most powerful tool which we can quickly bring to bear upon threatening pest populations. They are highly effective, can bring a pest population to acceptable levels immediately, are adaptable to most situations, and are reasonably economical. We should note that all the pest management tactics are meant to prevent populations from reaching damaging levels. However, when pest populations reach the economic threshold, insecticides offer the *only* practical control measure to reduce the pest population to acceptable levels. It should be added that insect pathogens can be used also as a remedial measure in certain situations.

In 1969, the U.S. National Academy of Sciences concluded that ". . . a major technique such as the use of pesticides can be the very heart and core of integrated systems. Chemical pesticides will continue to be one of the most dependable weapons of the entomologist for the foreseable future . . . There are many pest problems for which the use of chemicals provides the only acceptable solution. Contrary to the thinking of some people, the use of pesticides for pest control is not an ecological sin. When their use is approached from sound ecological principles, chemical pesticides provide dependable and valuable tool for the biologist. Their use is indispensable to modern society." (NAS 1969).

These are impressive credentials. Certainly IPM programs will continue to depend upon pesticides as a major component to assure program success and production stability. But "assured" success and production stability with insecticides have become more costly and difficult to maintain. At this time, there are several pest problems in different parts of the world where continued successful use of available insecticides is in some jeopardy. Largely due to insecticide resistance, severe losses in crop productivity are expected and have already occurred in a few instances.

There are a number of limitations associated with insecticide use but, briefly, the major ones are as follows:

- Through the selection process, many strains of pests have developed resistance to one or more chemicals — well over 400 species of insects and mites at this time. Nearly all of these are important pests. It is

now apparent that all organisms have the ability to develop resistance — plant pathogens, rodents, weeds, nematodes, etc. In fact, the problem in the case of rodent resistance to certain anticoagulants is considered serious, as is the rapid development of resistance in plant pathogens in recent years to the systemic fungicides.

- Insecticides generally provide only temporary reductions of pest populations which often quickly resurge (sometimes to higher and more threatening levels), necessitating repeated applications.

- Outbreaks of secondary insect pests resulting from destruction of their natural enemies.

- Undesirable effects on non-target organisms including pollinators, fish, birds and other wildlife, parasites and predators, the crop plant, man and his domestic animals, and the general environment, including water and the atmosphere.

- Residue hazards on target crops and also off-target crops (e.g. drift of insecticides).

- Direct hazards during applications.

INSECTICIDES AS COMPONENTS OF IPM PROGRAMS

With these comments as background, it is appropriate now to consider insecticides as a supporting component of IPM programs. How do we evaluate the impact of application upon the crop ecosystems and will the application cause disruption invalidating the program? Perhaps the simplest bit of information in the mind of an experienced entomologist is which insecticide — or, in most cases, insecticides — will kill a particular pest. But the experienced entomologist knows that, although many chemicals may kill the pest, some are preferred to others. Certain chemicals may be safer to use, others cause less disruption in the crop ecosystem, perhaps largely sparing predators, parasites, pollinating species, etc. Intelligent decisions can only be made after considering many factors involving hard data from properly designed field experiments. With these data, insecticide application can be justified when the benefit/risk ratio is clearly tilted in favor of application.

As pointed out, it is extremely important that insecticides are used in the context of integrated control programs. Used improperly, the system can be and usually is destroyed. Our colleague, Dr. M.J. Way in England, suggests three considerations: "first, the prerequisite of using pesticides only when necessary to avoid predictable economic damage, applying them by the most effective techniques at correct times and in the minimum dosages needed to get the required results; second, integrating pesticides with other methods of control for particular pests or pest complexes in such a way that the pesticides complement and supplement other methods of control when the latter cannot keep pest populations below economic injury levels. Third, there is the question of the acceptability of integrated methods of control that usually demand more sophisticated techniques and decision making procedures than those needed for a simple chemical regime." (See Fig. 1)

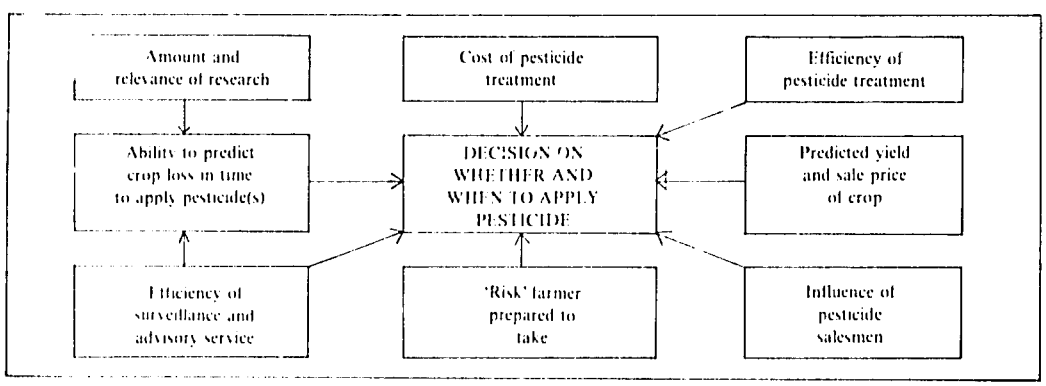
It seems appropriate at this point to amplify the above statement and discuss in some detail how insecticides can best be used to assist in developing and maintaining useful integrated control programs. First, we must recall that natural enemies (biological control organisms) constitute a central element in most, perhaps all, integrated control programs in agricultural fields. It is doubtful that we can long continue to produce most agricultural crops in the total absence of natural enemies. Destruction of natural enemies with insecticides must be avoided if at all possible. Second, we must, consequently, seek selectivity in use of insecticides. "Selectivity" simply implies the use of insecticides to reduce the target pest population to an acceptable level below the economic threshold with minimal disruption to other components in the crop ecosystem.

Before discussing means to make insecticide use more compatible with integrated control programs, there are two concepts suggested recently:

- Substitute treat-when-necessary insecticide applications for commonly employed routine-treatment insecticide schedules.

- Recognize that 100% control of most insect pests is not required to prevent economic loss. This concept

Figure 1: Factors and processes influencing decision-making on whether and when to apply a pesticide. The availability of economic thresholds greatly simplifies the decision process.



is particularly viable where selective insecticides have been employed, leaving natural enemy populations virtually intact. It has been estimated that recognition and employment of just these two principles would reduce insecticide use in the United States by as much as 50%.

USE OF ECONOMIC THRESHOLDS

Recognizing that insecticides should be used to supplement rather than supplant natural enemies, cultural controls and other control techniques which improve the effectiveness of insecticides while reducing ecosystem disruption are to be commended. "Timing" insecticide applications can reduce insecticide load in the crop ecosystem mainly through reduced need for repeated applications. Proper timing depends on many factors including an understanding of the pest and crop phenology and their associated interactions. Ultimately, insecticide application can be timed best when economic thresholds are established. The economic threshold is the pest population density at which control measures should be used to prevent an increasing population from reaching a density that causes economic injury or loss.

Much has been said about economic thresholds in the last two decades. Unfortunately, far too few have been established to date. Generally economic thresholds take several years to establish but, once available, much of the guess work is taken out of application. Expensive and environmentally damaging unnecessary applications are largely eliminated while economic crop losses, due to lack, or poor timing, of treatments are avoided also. Economic thresholds are never totally accurate because of fluctuations in productivity, crop price, treatment costs and a host of other factors, but they are essential to intelligent use of insecticides and are, therefore, a central factor in IPM programs.

SELECTIVE USE OF INSECTICIDES

Selectivity is a major route to compatibility of insecticide use with the crop ecosystem. Selective pest control attempts to minimize detrimental effects on other components in the environment, including natural enemies, as opposed to disruptive practices such as the commonly used application, by airplane, of a broad-spectrum insecticide. Not only are such practices detrimental to the environment, but they destroy IPM programs. Yet selectivity in insecticide use is available and there are many examples of successful programs based upon selectivity. These should be encouraged.

PHYSIOLOGICAL SELECTIVITY

Physiological selectivity (sometimes called intrinsic selectivity) has been developed most elegantly in the case of herbicides. Entomologists would like a similar degree of selectivity so they can reduce a pest population with little effect on populations of natural enemies. All insecticides are selective to some degree but few exhibit the type or degree of selectivity desired for IPM programs. Insecticides which are active only on a certain pest or to a group of pests would be ideal, but few have been developed. Many specific acaricides have little, if any, impact on beneficial insect species, although they may cause high mortality of predaceous species of mites. Insect diseases act in a selective manner. *Bacillus thuringiensis* and the first virus diseases are available for commercial application. It is also possible that chemicals such as juvenile hormone mimics and chitin inhibitors, may see practical application.

Physiologically selective insecticides are ideal but not readily available. The chemical industry has pointed out that development of such chemicals is an enigma. The potential market is limited and the enormous costs of development are discouraging. Nevertheless, physiologically selective compounds, although limited in number and utility, are available and new ones are developed occasionally.

Experience has demonstrated, however, that most selective chemicals, if applied on a repeated basis, deplete beneficial insect populations alarmingly after several applications.

ECOLOGICAL SELECTIVITY

Physiological selectivity is extremely desirable but availability of a large number of insecticides with this characteristic cannot reasonably be expected. Ecological selectivity, however, can often be developed from available insecticides; in fact, the development of ecological selectivity is an interesting challenge for the field entomologist. In most cases the development of ecological selectivity requires a detailed knowledge of the pest biology and ecology and how this pest interrelates with the crop.

There are a number of techniques which can be investigated for potential ecological selectivity. There is nothing mysterious nor particularly new and complex about most of these. In fact, some involve nothing more than common sense and experience. As most are self evident, little discussion is given with the following.

Dosage. There are several examples of a high degree of selectivity when dosage is reduced. A full recommended dosage may be, for example, 8 ounces per acre and it was found subsequently that 1 or 2 ounces gave adequate pest control. The reduced dosage resulted in little effect on the natural enemy populations, including parasitic Hymenoptera, whereas the higher rate virtually wiped out beneficial parasites, predators, and pollinators.

Formulation and methods of application. In some situations a broad-spectrum insecticide will be selective if the formulation and method of application are changed. Applying a granulated formulation to whorls of maize prior to tassel development is more effective on fall armyworm and certain stem borers than spraying the entire plant, and it minimizes subsequent buildup of spider mite, aphid and other insect pest populations as the natural enemy populations are left.

Restriction of treatment area. There are many examples where treating only part of a field or a selected area of the plant (spot treatment) is effective. The majority of the field is not affected and it allows biotic regulation to act. In fact, examples exist of crop

management which encourages pest concentration in restricted areas which can be treated. Only a small percentage of the field is involved. Treating locusts when still wingless in their breeding grounds is one of many examples.

Baits. Poison baits are effective and have been used for many years. For some time the use of baits declined but the incorporation of small amounts of an organic insecticide in an attractive bait is making a strong comeback. They can provide a high degree of selectivity. It does not make good sense to spray a seedling cotton plant with a broad-spectrum insecticide, for example, where the same insecticide in bait form is equally effective when spread along the row of plants and maximum selectivity also results. A similar situation exists in the case of some fruit fly species where a liquid bait plus a toxicant can be applied to a small portion of a tree. The fruit flies are destroyed as they are attracted to the bait.

Seed treatments. Several authors have pointed out that seed treatment is effective on many insect pests (the seed maggot complex, wireworms, rootworms, etc.). Often, seed treatments have given control comparable to row sprays and broadcast treatment which use the same chemical at many times the total toxicant per acre. For example, dieldrin at 32 g/acre in a seed treatment was about as effective as 4.5-6 kg/acre broadcast. The advantages are obvious as seed treatment costs less, causes less environmental contamination, non-target species receive far less exposure, cost for application equipment is largely eliminated, and there is far less selection pressure for development of resistance.

Systemic insecticides. Many systemic insecticides have useful properties in the context of selectivity. Some are absorbed rapidly into the leaf when sprayed and soon become essentially unavailable to insect species not feeding on the treated plants. Seed and soil treatment result in the chemical (or its toxic metabolites) being translocated upward into foliage and being selectively toxic only to phytophagous species. However, several research workers have noted that aldicarb is sufficiently toxic to some predator species, which supplement their diet of prey with plant juice, so that some selectivity is lost with this material. Nevertheless, systemic insecticides, although few in number, have been useful in IPM programs particularly for aphids, mites, leaf hoppers and for a few other insect species.

Selectivity through short persistence. A special case exists where a broad-spectrum insecticide may be somewhat selective through a very short period of residual activity. Thus insects migrating into the treated area are unaffected except, perhaps, through a reduction in prey in the case of beneficial insects. Also, the fact that parasitic Hymenoptera inside cocoons in the pupal stage can emerge a few days later into an environment without a toxic residue is of importance in maintaining the natural enemy population, albeit in reduced numbers.

CONCLUSIONS

There is much more that could be added to this discussion and perhaps some of it should be. For example, the principle of leaving a significant level of pests following insecticide treatment, although reduced to acceptable levels (the dirty-field technique) could be explored further. Also, there are a number of recent advances in technology which may provide new tools for use in IPM. Sex pheromones are already and increasingly used in population survey, detection and, in a few cases, prediction. The insect growth regulators may see utility given more time and research. Certainly, cultural controls, host-plant resistance and other older techniques are quite properly receiving renewed interest and research support. With time, we can expect advances through molecular biology and gene transfer.

Research on alternatives to conventional insecticides have demonstrated conclusively that none of these techniques or tactics will replace the need for insecticides. Many countries in the world do not use enough insecticides to obtain essential gains in agricultural production. Conversely, in the United States, society may not permit the continued profligate use of pesticides of the past two or three decades. In many instances it has been counter-productive for farmers to continue this heavy use of insecticides because of factors already mentioned. Certainly, these factors include environmental effects, loss of pest population regulating natural enemies, and pesticide resistance — all critical to IPM programs.

It is important that integrated pest management programs be developed. Globally, it is the top priority in pest control. It is exceedingly important, for tropical subsistence farming as much depends upon their ability to increase and stabilize productivity. Hopefully the farmers in developing countries will profit by the recent progress (and mistakes) made in other parts of the world. Insecticides will remain an indispensable and central tactic in our developing IPM programs, but we must learn to use them in the context of our ecosystems. Fortunately, there is a general and accelerating move towards the IPM concept in the professions of plant protection.

REFERENCE

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DISCUSSIONS

Q. (Mlambo): Does the U.S. government regulate pesticide exports by American companies?

A. (Alford): The U.S. government does not regulate companies, but it requires written acknowledgement from importing authorities that the latter wish to import the chemical in question.

Pesticides: How to Decide

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It is important to realize from the beginning that the question is not how to decide whether pesticides should ever be used or should be eliminated altogether. Pesticides play an essential role in food production and disease control, that is to say, in human welfare. Rather, the title question must be taken to refer to specific decisions relating to pesticide selection and use in any particular situation given the great diversity of factors which must be taken into account.

There are two very important general questions here: "Who shall decide?", that is, which individuals or groups shall have the authority to prescribe or proscribe the use of particular pesticides and practices, and whose opinions and interests should be considered in making these decisions; "On what bases should decisions be made?", that is, what factors and what possible consequences should be considered and how should they be weighed if they are in conflict. This is fairly commonly referred to as undertaking a cost (or risk) benefit analysis, but this implies that the costs and benefits can be clearly defined and that they can be quantified and evaluated in terms of a common medium, such as money.

These two general questions may then be followed by more specific ones, such as: Which product or formulation to use in a particular situation, when use of a particular product is cost-effective or advisable, how much to use and how often, how to protect the users, the general public and the environment, and what sort of regulatory control is needed. Clearly, these questions represent the overall subject of this workshop, so I will just briefly discuss the general questions of "who decides" and "on what bases," in relation to current USAID practices regarding assistance for pesticide procurement and use.

In the context of this workshop, it is also particularly appropriate to consider the influence of the special conditions prevailing in developing countries. While pesticide use is increasing greatly in the developing world, the long history of intensive use has been primarily in the developed countries. It is important to ask how the lessons of the past may be applied to the present and future.

WHO SHALL DECIDE

Except in cases where a government agency or other organization implements a regional pest management program, the decision to apply a particular pesticide at a particular time ultimately rests with the individual farmer. However, the farmer's decision is constrained and influenced by a variety of factors, each of which is determined by decisions made by a host of other individuals and institutions. For example, pesticide availability and cost are determined in part by commercial interests and in part by the government.

When pesticides are distributed free of charge by manufacturers or subsidized by the government, a farmer is clearly more likely to make liberal use of them than if he must pay their real cost. On the other hand, he may not be able to obtain a material he would like to use, either because no commercial enterprise is interested in providing it or because of import or distribution restrictions imposed by the government. The decision to spend money to purchase and apply pesticides should also depend on the market value of the crop, and this in turn may be controlled by supply and demand or by government pricing policies. Given that the farmer decides to expend resources on crop protection, the approach that he takes will be influenced by his own experience and by the information and guidance which he receives from others, including sales representatives and extension agents representing the policies of their respective companies and institutions.

All of these factors will necessarily play a role, but just who else should have a voice in the decision-making process is a very difficult and complex question. There are valid differences among the interests, concerns and priorities which different individuals and segments of society bring to the issue of pesticide use. The impacts on the farmer are obvious; he usually bears the most direct consequences, both positive and negative; it is his crop and consequently his livelihood which will either benefit or suffer and, particularly in the case of the small farmer who relies on family labor, he and his family that are usually most at risk from any toxic effects.

To the extent that other segments of society are likely to be affected, it is appropriate that their interests also be represented. However, particularly in an international context, it may not be easy to reach agreement on which individuals or groups are decision making. For example, while environmental groups in the US may claim the world environment as a common resource and heritage belonging equally to all of its inhabitants, officials or citizens of developing countries may counter that what lies within their borders is theirs to control, and that they have had little voice in environmentally related decisions made in developed countries.

There is also the difficult question of responsibility and authority. There are many who hold the view that because chemical pesticides originated with European and American technology, and because the commercial sectors of these countries have so effectively promoted the use of these materials throughout the world, their governments now bear the responsibility of controlling distribution and protecting the populations and environments of developing countries from hazards associated with pesticide production, use and abuse. Others, however,

contest the authority of the governments of exporting countries to interfere either with private commercial enterprise or with the affairs of other sovereign states.

The question of authority and responsibility for pesticide use within AID assistance projects was settled in the U.S. courts in the early 1970s, when it was ruled that the National Environmental Policy Act of 1969 should apply to all AID programs as well as as to domestic policy. To comply with this legislation, AID has developed its own internal regulations (AID Regulation 16) which determine its policies in relation to pesticide use as well any other activities which pose a possible threat to the environment.

Regulation 16 specifies that any AID project involving the use of pesticides must be accompanied by an environmental assessment which defines the potential hazards to the population and the environment and proposes specific measures to mitigate them. The extent of this assessment is related to the degree of hazard represented by the pesticides requested, as determined by the classification and the registration status assigned to them by AID's sister agency, the United States Environmental Protection Agency (USEPA). EPA has the responsibility to register commercial products for specific agricultural and public health uses, and to classify registered products either for "general" use (available to any adult purchaser), or "restricted" use (to be sold only to trained and licensed personnel). AID follows EPA registrations with regard to the use of specific materials on particular crops, but in special circumstances may accept registrations from certain other countries for products not registered in the U.S. To date, no products for which the EPA registration has been cancelled, withdrawn or suspended have been furnished through AID projects (although provisions do exist for the Administrator to allow such use in exceptional circumstances).

Since the inception of Regulation 16, AID has not approved any project involving the distribution of restricted pesticides to small farmers. When it is judged necessary to approve the use of a product which is restricted within the U.S. on the basis of direct hazard to the user, similar restrictions are placed on their use within the AID project to help ensure that the pesticides are handled only by properly trained and equipped personnel. If, as if often the case, a sufficient number of trained applicators is not available, the project will include a training component as well.

In short, AID takes an active role in making decisions regarding the selection and use of pesticides within its assistance programs, generally applying the same policies as have been developed for domestic purposes. AID also considers other aspects in providing international assistance for pesticides, such as the compatibility of the proposed use with an integrated pest management (IPM) approach, the availability and comparative efficacy of alternative chemical and non-chemical control methods, the availability of facilities for pesticide storage and disposal and the capability of the requesting country government to regulate pesticide distribution and use. AID also strongly supports research and development of IPM technology as an integral part of crop protection and agricultural production. Therefore, the environmental assessments also must evaluate the compatibility of the proposed use with an IPM approach, and the availability and comparative efficacy of alternative chemical and non-chemical methods.

In keeping with the Agency's fundamental strategy to promote the development of human resources and institutional capabilities, many projects include components to support and strengthen government agencies responsible for pesticide regulations, environmental protection and agricultural research and extension.

This month, the World Bank will be announcing its own new pesticide policy, developed in collaboration with AID. However, it must be recognized that commercial channels supply a far greater quantity of pesticides to developing countries than do direct assistance programs, and that therefore it is important to consider the sort of controls which might operate in relation to the private sector.

With regard to U.S. manufacturers, the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) requires that prior to any sale of an unregistered pesticide to a foreign purchaser, the purchaser must certify in writing that he understands that the material is not registered in the United States. A copy of this certification is passed to the government of the importing country to notify officials of the sale. In addition, all governments worldwide are automatically notified annually by the State Department of any cancellations or suspensions of U.S. pesticide registrations. The Organization for Economic Cooperation and Development (OECD) and the United Nations Environmental Program (UNEP) are in the process of implementing similar notification procedures. However, in all cases, the decision of how to act on the information provided remains with the government of the importing country.

It is only appropriate that the authority and responsibility for decisions concerning pesticide use within a country (whether the U.S. or any other nation) lie with the citizens and government of that country. However, this places a heavy responsibility on these governments to develop and enforce effective legislation. Also, because many of the problems and concerns surrounding pesticides are global in scope, it is also crucial that independent nations join together to work toward developing and adopting internationally accepted standards and practices.

ON WHAT BASES TO DECIDE

The greatest problem facing decision makers at all levels is how to determine the actual costs and benefits of pesticide use. This is equally true of the small farmer trying to decide whether to expend some of his small supply of capital on pesticides, or the AID Agricultural Development Officer designing a project for his or her mission and of the government minister contemplating a ban on an effective but highly hazardous product. It is not easy to define and assess costs and benefits which may be short or long-term, direct or indirect, and quantifiable or non-quantifiable, or to evaluate and compare the importance of consequences which may be economic, ecological, sociological, medical or esthetic in nature.

Even in the simplest case (the short-term, strictly economic point of view) it is difficult to evaluate the cost-effectiveness of pesticide use. This is largely due

to the fact that there is no such thing as a pest per se, only organisms which achieve pest status, primarily as a function of population levels. As already noted by many authors (perhaps first by Stern et al., 1959), the critical element in cost-effective control of a potential agricultural pest species is establishing an economic threshold level, defined as the population density at which the yield reductions due to that species equal the costs of controlling it.

This is an extremely delicate balance affected by a wide variety of factors, including the availability and cost of control measures, the market value of the crop, and the influence of other factors (such as other pest species and the availability of water or fertilizers) on the overall condition of the crop. All of these factors are likely to be particularly variable in developing countries.

In light of the importance of these variables, a static threshold is meaningless; it must be calculated as a function of the conditions prevailing at any particular time. Added to this are the problems of relating pest population levels to crop damage levels, assessing densities at any point in time and accurately predicting growth trends in order to anticipate damaging outbreaks in time to intervene effectively.

Most commonly, the farmer is forced to make pest control decisions in the absence of any or all of this critical information, so that it is not surprising if his decisions are imperfect. The need for further work in these areas is well recognized and there are numerous research programs directed at developing improved assessment methods and realistic thresholds or dynamic threshold models (e.g. Dively, 1983; Murphey, 1980; Stern, 1973; Headley, 1972). Still, it must be admitted that in most cases, particularly with regard to subsistence agriculture in developing countries, we are far from being able to provide farmers with the specific guidance they need to make their critical decisions. There are even those who would argue that this is an unattainable goal.

Nevertheless, the economic threshold level remains a very valuable concept in that it forces a recognition that there is a break-even point (even if it cannot be determined with complete accuracy), a level of pest population or crop damage below which it does not pay to intervene. Forced to choose, most farmers will err on the side of using chemical controls more often and at considerably greater expense than is cost-effective, because their essential priority is usually to reduce risk rather than maximize profit. Within its research and development programs, AID has placed a high priority on demonstrating that in any given situation, while some pesticide use may be good, more is not necessarily better.

If the short-term cost-effectiveness of pesticide use is difficult for a farmer to evaluate, the situation becomes far more complicated when the scope of the analysis is broadened to include long-term economic consequences. The best recognized long-term costs of generalized pesticide use are the so-called "pesticide treadmill" (also sometimes referred to as the "tiger trap" because "he who rides a tiger dares not dismount") and the evolution of pesticide resistance in pest species. Together these factors can greatly decrease the long-term cost-effectiveness of the chemical approach, causing a steady increase in the dosages of pesticides needed to maintain yields and, ultimately, rendering them completely ineffective as a means of crop protection.

Both of these factors are also likely to be particularly significant in developing countries because, under the tropical conditions prevailing in most of these areas, natural control agents are particularly important in suppressing pest population levels, because there are so many potential pest species ready to step in and become key pests, and because pest populations can rebuild very quickly from a few naturally resistant individuals which survive the pesticide application. The tendencies of farmers to rely on a limited number of familiar, available materials, to prefer materials with high kill ratios, and to apply too large doses at too frequent intervals also serve to aggravate the problem.

In light of these well-known effects, it is becoming more and widely recognized that over-reliance on chemical control presents a significant danger to agricultural production in the long term. Smith (1969) and Smith and Reynolds (1971), provided an illustrative example in an account of the history of cotton pest control in the Canete Valley in Peru. Originally, yields were at respectable levels despite some insect damage (the subsistence phase). Following the generalized application of organo-chloride pesticides, yields increased dramatically (the exploitation phase). Soon, however, due to the elimination of natural enemies and the development of pesticide resistance, both primary key pests and induced secondary pests increased dangerously (the crisis phase), and chemical pesticides became largely ineffective (the disaster phase). Cotton growers in that area were thus forced to return to a more ecologically based, integrated approach. Legal sanctions were imposed on the use of organo-chlorine pesticides and they were largely replaced by less broadly toxic materials; culture practices were improved and effective biological control was introduced in the form of *Trichogramma* egg parasites. In this particular case, yields eventually returned to, and even exceeded, original levels. Unfortunately, this may not always occur.

Scenarios such as this one have been repeated or are now underway in many cropping systems throughout the world. It is essential that agriculturalists in areas which have not yet become heavily dependent on pesticides emphasize the integrated pest management approach from the beginning, thus avoiding the seductive trap of the exploitation phase. In recognition of this, support for IPM programs has been made a high priority within the USAID agricultural development strategy.

An additional important cost which must be considered by those carrying the responsibility of making public policy decisions relates to the prevalence of insect-borne infectious diseases in tropical regions. The use of the same pesticides for agricultural purposes and disease vector control promotes the rapid development of pesticide resistance, creating serious problems and increasing costs in public health programs as well as in agriculture.

In addition to the complexities of short and long-term cost effectiveness, pesticide use has well-known and important potential consequences in other areas such as human health and safety and environmental protection. The difficulties inherent in trying to give

appropriate consideration and weight to such diverse factors have been discussed in depth by a number of authors (Pimentel, 1980; Bull, 1982; Reicheldorfer and Bottrell, 1985; Davies *et al.*, 1982) and need not be belabored here. However, it is appropriate to emphasize that any attempt to analyze the overall risks and rewards of a particular pesticide use must be based on a thorough understanding of the specific conditions and circumstances prevailing in these areas. This includes considerations of climate, natural and human resources, institutional capabilities and national priorities.

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DISCUSSIONS

Q. (Bwankosya): Very often it is the manner of pesticide application by farmers which leads to undesirable side effects. What is USAID's view on that problem?

A. (Kiss): USAID has sometimes insisted on the inclusion of proper pesticide application equipment in their aid package, or else on the use of granular formulations, whenever there are indications that the local applicators do not have proper equipment. Sometimes it is the training component that is insisted upon.

Comment (Gaudet): There are many difficulties in trying to assess the applicators' techniques and equipment. Some countries lack suitable systems for monitoring farmer activities.

Q. (Osman): Most information available on organo-chloride chemicals like DDT is based on work in countries with temperate climates. There are indications, however, that these chemicals degrade faster in tropical environments. What is the rationale in the USAID's policy that because DDT is restricted in the USA, it should necessarily be so restricted in aid-recipient countries?

A. (Kiss): There are other studies in the tropics which give contrary indications, implying perhaps that more research on this is still necessary.

Comment (El-Sebae): Even if DDT degraded easily in tropical environments, its metabolite DDE would still be there, and we know that DDE is also toxic as well as carcinogenic.

II.
Pesticide Use in the Region

COUNTRY PAPERS:

D.R.B. Manda — Pesticide use by the cash crop farmer in Malawi

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A. Stroud — Considerations in pesticide technology transfer to small farmers

J. Cosse — Effect of pesticide residues on African agricultural exports to Europe

Pesticide Use by the Cash Crop Farmer in Malawi

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INTRODUCTION

Agriculture in Malawi can be divided into two distinct sub-sectors, namely; estate and small holder sub-sector. Land on estate is under leasehold or freehold while small holder land is under customary ownership.

The estates cover a total area of about 475,000 ha or 15% of land available for cultivation and supply 65-70% of total agricultural exports, mainly tobacco, tea, sugar, coffee and tree nuts. As can be seen, estates grow mainly cash crops. Small holders grow all the food crops as well as all fruits and vegetables.

The use of pesticides has become an integral part of crop production and will remain an indispensable tool for improved pest control. The intensification of crop production, as seen in Malawi today, has been accomplished through higher fertilizer levels, increased plant densities, shorter rest periods between crops and the general improved cultural practices. All these call for wide use of pesticides to control weeds, pests and diseases. Today, agricultural fields are real battle-fields. Anything wanting to grow, creep or fly on the farmland is inevitably caught in the firing line of the chemicals (insecticides, fungicides and herbicides) and perishes in it. All these chemical weapons together go by the aggressive name of pesticides.

Over the past few years, pesticides are being used excessively in Malawi. Indeed almost every agricultural product is treated at one stage with a pesticide. Several chemicals have become available to producers since the early 1960s due to expansion and intensification of agriculture after political independence and much of the increased yields now being achieved in agriculture can be attributed, in part, to the reduction of losses through regular application of pesticides and other chemicals. The rapid rise in the popularity of pesticides is due primarily to their increased effectiveness, low cost and availability. Farmers have come to rely much less on traditional pest control measures such as crop rotation. This has suited Malawi since land is very limited. Regular application of pesticide has become a standard practice and it is strongly felt that pesticides will remain the major means of control for a long time.

Though the important contribution of pesticides in increasing agricultural yields has been recognized, concern has also grown over the potentially harmful effects of pesticides on man and his environment. Table 1 shows the quantity and value of agricultural pesticide imports in Malawi for the last 12 years.

During the 12-year period under review, yearly import figures of liquid formulations in terms of total quantity have shown much less variation when compared to powders, the lowest being 232,000 (1981) and maximum 428,000 (1982). In the case of powders, however, the variation is remarkably high — 101t in 1981 and 1,185t in 1978, mean being 555t per annum.

TABLE 1
IMPORTS OF AGRICULTURAL PESTICIDES

Year	Liquids		Powders	
	Quantity (1,000 l)	Value (1,000 MK)*	Quantity (1,000 l)	Value (1,000 MK)
1971	372	221	431	324
1972	404	236	482	454
1973	263	232	457	532
1974	4[illegible]	427	675	1012
1975	408	757	1093	2208
1976	414	888	462	7[illegible]
1977	295	667	750	1552
1978	252	526	1185	1768
1979	284	1008	473	1584
1980	233	1096	278	892
1981	232	953	104	550
1982	428	2139	271	1324

Up to November only *MK = Malawi Kwacha approx. US$0.58

PESTICIDES USE BY CROP

Tobacco

Tobacco is a major export crop for Malawi. During 1984, over 79,000 t of leaf were produced from a total of 78,000 ha. The crop is attacked by a broad spectrum of pests, most feeding on the leaves or the roots and the actual pest load on a growing crop is often quite heavy. Many tobacco importing countries have very rigid restrictions concerning residues of pesticides such as DDT, dieldrin, aldrin, etc., on the tobacco leaf. The low residue limits do not permit the use of these chemicals on the plant foliage. During the 1984 season the quantities of pesticides shown in table 2 were used.

TABLE 2
PESTICIDES USED ON TOBACCO DURING THE 1984 SEASON

Nematicides		
Methyl Bromide	98% Tech	925,000 kg
Ethylene Dibromide	92WM	181,000 l
Insecticides		
Cypermethrin	25EC	2,000 l
Monocrotophos	40WS	6,000 l
Acephate	75SP	3,500 l
Dimethoate	40EC	31,000 l
Dimethoate	20WP	20,000 l
Fungicides		
Copper Oxychloride	85WP	13,000 kg
Benodamil	50WP	250 kg
Benomyl	50WP	1,000 kg
Anilazine	50WP	1,000 kg
Thiram	80WP	12,000 kg
Herbicides		
Metolachlor	20EC	2,500 l
Trifluralin	48EC	250 l
Suckeride		
Antak	78WS	60,000 l

Tea
Tea, another major export crop for Malawi, has basically been an estate crop, but over recent years, smallholder production has been encouraged. There are now over 18,500 ha planted with tea producing about 38,000 t. About 13% of this is smallholder tea. The major pesticides used during 1984 were as follows:

Cypermethrin	25EC	1,200 l
Pirimiphos methyl	50EC	1,800 l
Paraquat	25Ag.C	33,000 l

Sugarcane
There are two large sugarcane estates covering an area of 16,825 ha and producing 175,300 t of made sugar each year. From 1976, Malawi has been an exporter of sugar with exports rising steadily every year. An ethanol plant has also been established to use molasses, and ethanol is mixed with petrol. Both estates are professionally managed by Lonrho Limited. Since no serious pests are reported on sugarcane, practically no insecticides are used. However, fairly large quantities of herbicides are used for weed control. Table 3 shows the pesticides used on sugarcane estates during the 1984 season.

TABLE 3
PESTICIDES USED ON SUGARCANE IN 1984 SEASON

Eptam	72EC	10,500 l
Ametryne	80WP	7,200 kg
Atiazine	80WP	7,200 kg
Sucomiss 'Ametryne 53% 2,4-D 27%)	80WP	36,000 kg
2, 4-D Sodium		5,100 kg
2, 4-D Amine		3,000 kg
MSMA	WSC	19,000 l
Sencor (Metribuzin)	80WP	2,000 kg
Tordon (Pidoram)	2 lb/gal	1,250 l
Baygon (Propoxur)		1,050 l
DDT	75WP	1,050 kg
Dieldrin	50WP	500 kg
Aldrin	40WP	500 kg
Temik	10G	Several tonnes

Cotton
Cotton has been traditionally a smallholder crop though in the past three years estates too have started growing it in an effort to diversify the estate sector. Over 40,000 ha are grown to cotton each year in the warmer parts of Malawi. Cultivation is all rain-fed. During 1984, 260 kg of DDT 75WP, 420 Carbaryl 85WP and 20 of Dimethoate were used on cotton. On estates where tobacco and cotton are grown on the same land, Cypermethrin is used instead of DDT/Carbaryl mixture in order to avoid tobacco contamination. Research is continuing to find a cheap substitute for DDT.

Coffee
There are about 8,000 ha grown to Arabica coffee in Malawi both by smallholders and on estates. During 1984, Malawi produced 60,000 bags of coffee. During 1984 the following pesticides were used:

Copper oxychloride	85WP	60,000 kg
Monocrotophos	40WS	4,000 l
Dieldrin	50WP	1,250 kg
Bisulfoton	5G	52,000 kg
Fenitrothion	50EC	5,000 l

Tree nut crops
There are 4,500 ha of cashew nut trees, mostly along the lakeshore, 3,500 ha of macadamia nut trees, and 2,700 ha of tung. The common pesticides used are dieldrin, 50WP, for termite control, dimethoate 40EC fenitrothion 50EC and propineb 70WP. The quantities are low at present.

Fruits and vegetables
This group of crops use large quantities of pesticides such as Diathane, M 45. They are not easy to quantify.

PRICE OF PESTICIDES

Estates normally buy their pesticides directly from companies or dealers, but smallholder farmers get most of their pesticides from the Agricultural Development and Marketing Corporation (ADMARC). This is a parastatal organization that supplies all farm inputs and buys farm produce from smallholder farmers. ADMARC normally buys large stocks of pesticides through tender and these are distributed throughout Malawi and farmers can get them either for cash or credit. ADMARC prices are lower than the ones charged by dealers. Pesticides prices are generally higher in Malawi because all pesticides are imported and there is no local formulation plant.

Due to some problems in Mozambique whose ports were our traditional import routes, Malawi is at present importing through ports of Dar es Salaam and Durban. These are very costly routes and imports are generally costly. The low usage of pesticides in Malawi is due to this high cost.

Availability

Normally all major pesticides are available, but Malawi being a land-locked country sometimes all the pesticides cannot be obtained in time, but on the whole most pesticides are available in spite of occasional delays.

Credit

ADMARC, smallholder crop authorities (for tea, coffee and tobacco) and the Ministry of Agriculture, operate a good credit program for the smallholder farmer. Farmers can get most pesticides as well as application equipment on credit. Credit is only in kind not cash. This has been done to avoid the situation where the small farmer is over-exploited by the large commercial companies or pesticide dealer, as his operations are too small to attract private banks. Pesticides are provided as seasonal credit along with seeds. Small packets or sachets, which are specially packed for use by the small farmer are used. Instructions are clearly written in English and local languages.

In the past, every single farmer had his or her own credit card. This made administration of credit cumbersome. Now, farmers have been organized in groups or clubs of 50-200 members. One credit card is used for the whole group. Since credit for the group is large, a good discount is given by ADMARC. Repayment is also much easier this way; average credit recovery is now 95%. If one farmer in the group defaults, the whole group is penalized. For the smallholder farmer, cotton is the only crop which uses most of the pesticides. These are Carbaryl, DDT and Dimethoate as is shown in table 4.

When farmers buy pesticide on credit 10% interest is charged per year and repayment is after sales.

Large-scale farmers get their seasonal financing for all costs, including cost of pesticides, from the National Bank of Malawi, Commercial Bank of Malawi and the Investment and Development Bank of Malawi. Each farm prepares a cash flow that includes all operations. The estates buy the pesticides from dealers or chemical companies. These also give some limited credit facilities normally not exceeding 120 days. But in some cases farmers pay after selling the crop.

TABLE 4

			Cash Price	Credit Price
Carbaryl	85 WP	85 g sachets	K0.38 t	K0.42 t
DDT	75 WP	85 g sachets	K0.17 t	K0.19 t
Dimethoate	20 WP	35 g sachets	K0.15 t	K0.17 t
Dimethoate	20 WP	130 g sachets	K0.57 t	K0.65 t

Distribution

ADMARC have a very good network in every rural administrative unit and town. Farmers do not have to travel long distances to buy pesticides. All dealers have main depots in major towns, and also distribute through stockists.

Equipment

A variety of spraying equipment are available in Malawi. Again, the smallscale farmer can get these through ADMARC while the large-scale farmer buys from dealers and stockists. Spare parts such as nozzles are occasionally unavailable, but on the whole this is not a major problem.

Farmer training

Extension staff and research staff run courses for grass-root level staff and farmers. Every district has both residential training centres and day training centres where farmers are trained in scouting and proper spraying techniques. For the estates, the chemical companies dealing in pesticides help in training the farmer through visits to farms, field days, and demonstration during the growing season. Guest speakers are invited to speak to farmers and a few farmers are also sent outside Malawi to see what other farmers do.

Conclusion

While concern is being voiced on pesticide as a health hazard for man and his environment, pesticide will remain an important input in farming for sometime. One cannot visualize a time when no pesticide will be used. Breeding for disease resistance might provide an alternative, but it is costly and time consuming. The quickest way to good pest control and quality harvest is pesticide. But Malawi is aware of the health hazard and certain precautions are taken. Tolerances applicable to Malawi are 1.00 ppm for DDT and 0.20 ppm for Dieldrin, Aldrin and Lindane. The Malawi Bureau of Standards tests all samples of tobacco taken to the auction floors (approximately 600 samples annually), and the above-mentioned levels are the only ones allowed. These levels are even lower than in Europe where some go as high as 10.0 and 8.3 ppm; necessary in order to safeguard out tobacco trade.

Pesticide Management in Developing Countries — Egypt, a Case Study

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ABSTRACT

In agricultural systems, soil is the main reservoir of the chemical pollutants. Soil generally has a loose texture and consists of solid mineral and organic matter, water and air spaces. The mineral portion of soil is formed from parent rocks by the weathering action of physical, chemical and biological processes. The organic portion consists of plant biomass in various stages of decay. High populations of bacteria, fungi, and animals such as earth-worms may be found in soil.

The solid fraction of a typical productive soil is approximately 5% organic matter and 95% inorganic matter. However, some soils, such as peat soils, may contain as much as 95% organic material. Other soils contain as little as 1% organic matter, for example sandy soils.

TYPES OF PESTICIDES USED IN EGYPT

Table 1 indicates types of pesticides used directly in soil or seed treatment. The list covers fungicides, insecticides and weed killers of different chemical structures. These compounds contaminate soil indirectly through drift and run off. These are the two main sources of contamination of the Egyptian soil that occur as a result of agricultural practices. Soil, climate, and pesticide structural properties are three factors primarily responsible for controlling the persistence of pesticides in soils (Kearney, 1977).

TABLE 1
PESTICIDES INCORPORATED IN EGYPTIAN SOILS

Compound	Pest to be controlled
Aldicarb (Temik (R)	Nematoda, thrips, aphids, spidermites
Carbofuran (Furadan)	Nematoda
Fenamiphos (Nemacur)	Nematoda
Carboxin (Vitavax)	Nematoda
Captan (Orthocide	Soil fungi
Endrin	Crickets and cut worms
DDT Lindane (30 9)	Onion nursery insects
Kitazin	Rice soil fungi
Lindane	Sugarcane pests
Diazinon	Sugarcane pests
Chlorpyrifos (Dursban)	Soil insects
Chlordane	Soil insects and termites
Trifluralin (Treflan)	Weeds
Fluometuron (Cotoran)	Weeds
Butralin (Amex)	Weeds
Pendimethalin (Stomp)	Weeds
Linuron (Lorox)	Weeds
Paraquat (gramaxone)	Weeds
Dalapon (Dowpon)	Weeds
Propanil (Stam F 34)	Weeds
EPTC (Eptam)	Weeds
Atrazine (pesaprimar primatal)	Weeds
Bromoxynil (octanoate) (Bromnal)	Weeds

TABLE 2
RELATIVE MOBILITY OF PESTICIDES IN SOILS

Very low mobility	Medium mobility	Rapid mobility
DDT	Monuron	TCA
Lindane	Diuron	Dalapon
Parathion	Linuron	2, 4-D
Chlorphenamidine	EPTC	Anitrols
Zineb	Azinphosmethyl	Bromacil
Morestan	Diazinon	Piclaram
Benomyl	Atrazine	Dinoseb
Dieldrin	Simazine	MCPA
Paraquat	2, 4, 5-T	
Trifluralin		
Heptchlor		
Endrin		
Aldrin		
Chlordane		
Toxaphene		

Source: Kearney (1977)

An important factor in assessing the significance of pesticides in the environment is their ability to move from the original site of application. They can move either vertically or horizontally through leaching down across the soil profile, erosion and movement of absorbed pesticides in soil particles, or by the vapour movement of a pesticide off the soil surface into the atmosphere.

In table 2, the relative vertical mobility of various classes of pesticides down the soil is shown. The insoluble chlorinated insecticides are almost immobile and tend to remain on or near the soil surface. Consequently, they may pose little or no threat to ground water purity, but are subject to surface erosion and movement is partly responsible for the appearance of pesticides in the aquatic environment. On the other hand the acid herbicides such as 2, 4-D, TCA and dalapon are readily leached in soils and may move to great depths during a normal growing season. Fortunately, most of these pesticides are usually degraded fairly rapidly in the environment and are not detected in ground water.

The annual load of pesticides used in the Egyptian

agriculture can be evaluated from the information in table 3 which presents the total amount of pesticides used during the period 1950-1983. The average annual use was 30,000 metric tons. That means an average dumping of 6 kg of pesticides per acre each year (Attia, 1977).

Insecticides constitute about 75% of the total imported pesticides in Egypt. Diversity of chemical structure and the rapid shift from one type to another was caused by the development of resistance in the cotton leaf worm to the different groups of insecticides (El-Sebae, 1981).

PERSISTENCE OF PESTICIDES IN SOIL

The chlorinated hydrocarbon insecticides have been shown to be highly persistent in the soil (Wattal 1972; Kearney *et al.* 1969). The relative persistence values of different types of pesticides at the normal rates of field application are indicated in table 4.

These data confirm the persistence of the chlorinated hydrocarbon insecticides on one hand and the easy dissipation of organophosphorous insecticides and the carbamate and aliphatic acid herbicides on the other.

TABLE 3
TOTAL ACTIVE INGREDIENT INSECTICIDES RELEASED IN EGYPTIAN AGRICULTURAL ENVIRONMENT DURING THE YEARS 1950-1983

Compound	Total a.i. metric tons	Years of consumption
Toxaphene	54,000	1955-1961
Endrin	9,500	1961-1974
DDT	13,300	1952-1971
Lindane	10,800	1952-1971
Carbaryl	20,000	1961-1968
Trichlorofon	6,200	1961-1966
Monocrotophos	7,800	1967-1973
Leptophos	5,500	1968-1975
Chlorpyriphos	11,500	1969-1983
Phosfolan	6,000	1968-1983
Mephosfolan	7,500	1968-1983
Other OP's	20,000	1968-1983
Methomyl	6,000	1976-1983
Fenvalerate	6,000	1976-1983
Cypermethrin	5,000	1976-1983
Deltamethrin	3,000	1976-1983

THE EFFECT OF SOIL TYPE ON PESTICIDE PERSISTENCE

The physicochemical characteristics of each soil type limit the rate of adsorption, leaching, degradation and translocation of each pesticide. Data in table 5 demonstrates the variation in properties of three Egyptian soil types (El-Sebae *et al.* 1969). The initial adsorption of Dowpon differed on the three soil types (table 6); being higher on the sandy type followed by the silty and then the clay type. However, a lot of Dowpon was lost through the sandy soil due to the higher evaporation and leaching rates. The high percentage of organic colloide in silty and clay soil

TABLE 4
RELATIVE PERSISTENCE OF PESTICIDES IN SOILS

Compound	Time for 75% loss
Chlordane	5 years
DDT	4 years
B HC	3 years
Heptachlor and Aldrin	2 years
Simazine	12 months
Atrazine, monuron	10 months
Diuron	8 months
Trifluralin	5 months
2, 4, 5-T	5 months
MCPA	3 months
2, 4-D	1 month
Diazinon	12 weeks
Disulfoton	4 weeks
Phorate	2 weeks
Malathion, Parathion	1 week
TCA	12 weeks
Dalapon, CIPC	8 weeks
EPTC	4 weeks

types account for their ability to hold residues for long periods. Similar data were observed by Ebeling (1963) and Aly *et al* (1979).

Pesticides adsorbed on the soil surface can vaporise. This partly explains the transport of pesticides and pollutants to areas far away from the original site. Table 7 presents the vapour pressure of different pesticides. The presence of many chlorinated hydrocarbons such as DDT, toxaphene, lindane and dieldrin in Scandinavian lakes and the Baltic Sea can be attributed to the transportation of its vapours by the atmospheric air and its precipitation by rain from the mobile particulates.

TABLE 5
CHARACTERISTICS OF THREE SOIL TYPES

Soil Type	pH	Water saturation (%)	Number of bacteria per g	Organic matter (%)
Sandy	7.8	18.9	50,000	0.09
Silty	7.1	38.8	112,000	0.70
Clay	8.0	60.7	211,000	0.75

TABLE 6
PERSISTENCE OF DOWPON IN THREE SOIL TYPES

	ppm after storage for			
Soil type	0 days	7 days	14 days	21 days
Sandy	29.95	17.5	3.5	0.5
Silty	27.30	20.5	15.5	8.0
Clay	24.85	23.0	17.5	12.0

Organic compounds, bound on humic acid and on soil in general, are quite stable and give rise to what is called unextractable residue (Khan, 1980; Manahan, 1979).

TABLE 7
PHYSICAL PROPERTIES OF SOME INSECTICIDES

Compound	Water solubility ppm (20-25°C.) (mg/L)	Vapour pressure mm Hg (20-25°C.)
DDT	0.0012	1.90×10^{-7}
Dieldrin	0.05	1.80×10^{-7}
Lindane	10.00	9.40×10^{-6}
Ronnel	1.08	8.00×10^{-4}
Chlorpyrifos	0.40	1.87×10^{-5}
Leptophos	0.0047	
Fenitrothion	30.00	5.40×10^{-5}
Methyl Parathion	55.00	9.70×10^{-6}
Parathion	11.90	3.78×10^{-5}
Malathion	145.00	1.25×10^{-4}
Mevimphos	miscible	2.20×10^{-3}

LEVELS OF PERSISTENT PESTICIDES IN EGYPTIAN SOILS

The concentration of organo-chlorine insecticides were determined in soil samples from the three governorates: El-Minia, El-Behera, and El-Dakahlia, in 1979 (Aly and Badawy 1981). The data are shown in table 8. The concentrations of the insecticides were much higher in soil samples than in the water samples. This reflects the tendency for accumulation of the chlorinated hydrocarbons in soils. El-Dakahlia samples were highly contaminated, a reflection of the differences in the background levels of pesticide applications.

Chlorinated hydrocarbons have been observed on sediments of such brackish lakes as Lake Mariut (Abo Elamayem *et al*, 1979) and in Lake Burullus (Askar *et al*, 1981). Although the chlorinated hydrocarbons have not been used for over 10 years because of resistance their levels in the environment significantly indicate that they are persistent environmental pollutants.

LEVELS OF HEAVY METALS IN EGYPTIAN SOILS

El Sokkary (1978, 1980) investigated contamination of roadside soils and vegetables, in cabbage and parsley, by the heavy metals: Hg, Co, Cd, Ni, Pb and Zn along Alexandria-Cairo Agricultural Highway. High levels of these metals, more than the permissible tolerances, were found in soils and plants near the road. The source of this contamination is vehicle exhausts.

HARMFUL EFFECTS CAUSED BY PESTICIDES AND HEAVY METALS IN SOILS

Edwards and Thompson (1973) reported that pesticides in soils affect animals which are non-target organisms such as the saprophagous invertebrates (e.g. earth worms, collombola), some Acarina and Diptera larvae which are essential in the breakdown of some kinds of leaf litter into its organic and inorganic constituents, leading to deterioration of the structure and fertility of soil.

Residues of organo-chlorine insecticides tend to accumulate in earth worms about 9 times as much as in soils, and 20 times in soil snails and slugs (Gish, 1970).

TABLE 8
CONCENTRATION OF ORGANO- CHLORINE INSECTICIDES IN SOIL SAMPLES AT EL-MINIA, EL-BEHERA AND DAKAHLIEH PROVINCES, AUGUST 1979

	Concentration in ppb					
Samples location	Lindane	Endrin	DDT	DDD	DDE	Chlordane
El-Minia 1	0.15	0.16	1.40	1.40	n.d.	0.26
El-Minia 2	0.24	0.19	1.30	1.10	n.d.	1.30
El-Behera 1	0.70	0.30	0.38	0.55	n.d.	n.d.
El-Behera 2	0.50	0.48	0.40	0.84	n.d.	n.d.
Dakahlieh 1	1.20	1.00	1.54	1.34	n.d.	1.20
Dakahlieh 2	1.25	1.50	1.70	1.50	n.d.	1.24

n.d. = no data

Such soil fauna organisms can be used to monitor levels of pollutants. This tendency also causes injury to the earth worms' and slugs' normal vitality and population.

Cole *et al* (1975) reported that subsurface application of aldrin caused reduction in the height of corn plant due to its phytotoxicity.

Hegazi *et al*, (1979) studied the effect of the application of a group of pesticides (Temik, Stomp, Dinoseb, Nata, Dursban, and Simazine) on N_2-ase activity in Giza clay-loam soil under rice cultivation. Field applications of all pesticides showed different inhibitory effects and the effects increased with increased doses and incubation period.

Carbamate and organo-phosphate insecticides were found to cause harmful inhibition of soil-dehydrogenase activity (Khalifa *et al*, 1980). Similar unfavourable side effects of other pesticides on different essential soil enzymes were also reported.

The organo-chlorine pesticides remain in soils for long periods of time. During that period, certain compounds which are mobile are translocated to areas where they accumulate. (Caro, 1969).

The favourable effects of heavy metals, such as copper and zinc is connected with their functions in enzyme activities and plant growth regulation. However, excessive concentrations of these metals in the soil are toxic to plants (Assche and Mey, 1977) Copper at concentrations above 40 ppm in soil appears to have little mobility and is highly phototoxic. It causes blackish-brown discoloration of roots, which often develop a syndrome commonly known as "barbed wire". Lead in the soil depresses transpiration and photosynthesis. Zinc has an antagonistic effect on iron and is toxic at concentrations of 125-500 ppm. So far, little is known about the complex and specific effects of these metals when found simultaneously.

METHODS FOR DECONTAMINATION OF SOILS

Bryce (1973) proposed certain solutions to problems of soil pollution by agricultural chemicals. By cultivation and related techniques chemical pollutants are brought to the soil surface where they are exposed so that evaporation and photochemical degradation is accelerated. Aeration and ploughing are recommended in this concern. Cropping with plants that accumulate pesticides has been suggested as another method for decontaminating soils. For example, uptake by resistant plants such as Johnson grass, maize and sorghum accounted for 25% of the atrazine applied to soil. Heavy irrigation has also been suggested as a means of accelerating the removal of contaminants from soil by heavy leaching.

Adding adsorbent materials has often been suggested as a means of making persistent chemicals less harmful. Adding activated carbon can decrease the activity of chemicals in soils. The possibility of enhancing the ability of micro-organisms to degrade pesticides has often been considered. The biodegradation can be stimulated by raising temperature, adding energy-rich materials such as sugars or various composts, or by maintaining the soil moist.

Jansen and Assche (1977) carried out a field experiment during two consecutive years, to check the influence of selective working: cation exchangers in a soil contaminated with the heavy metals, lead, copper, and zinc. After a single application of the cation exchanger of a macroporous polystyrol type, very positive and permanent effect of decontamination was observed.

El-Sebae and Abo Elamayem (1978) found that the activated carbon can be a good adsorbent for most of the pesticides in aquatic and soil systems.

LEGISLATIONS FOR SOIL PROTECTION

In 1979 FAO published a report on environmental criteria for registration of pesticides. The physico-chemical data required for prediction of hazards of a new pesticide include water solubility, rates of adsorption and desorption on soil, volatility, degradation and leaching in soil system.

The requirement of toxicity data of the new chemical on non-target organisms include soil micro-organisms particularly the N_2 fixation bacteria and also the soil macro-organisms with special reference to earth worms and other beneficial soil fauna.

These requirements emphasize the importance felt by legislators in putting criteria for regulation of registration of the new pesticides with the least hazard to soil fertility and productivity. Such regulations maintain management of chemical pollutants in agricultural soil systems.

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Pesticide Use in the Sudan Gezira: Past, Present and Future

by
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INTRODUCTION

The Gezira is an alluvial flat clay plain in Central Sudan at the confluence of the White and Blue Niles and lying between latitudes 13° 30' and 15° 15' North and longitudes 32° 30' and 33° 30' East. An area of 2,700 km² of fertile land. Before 1910, rain-fed crops were grown and the natural pastures of the savannah provided food for animals. The idea of utilizing the land properly came after studies on the Nile water were availed in 1904. This was followed by field experiments and a pilot farm for cotton production started in the 1910/11 season in a pump-irrigated area of 250 feddans*. The success of cotton production convinced the authorities to invest heavily on the crop and it was decided to construct a dam on the Blue Nile to supply water through gravity flow to the area planned for cropping in the Gezira scheme. Work on the dam started in 1913, with a break during the First World War and was completed in 1925. Now the dam provides 35 million m³ for crops grown in an area of 2.1 million feddan (12% of the total cultivated area in the Sudan) mainly with cotton (500,000), wheat (400,000), sorghum (330,000), groundnuts (260,000), vegetables (50,000), small areas of irrigated forests and fodder crops and the rest is usually left fallow. With 100,000 tenants farming the land, the Gezira scheme produces 75% of Sudan's cotton which earns 60% of the foreign exchange, 12% of sorghum, 60% of groundnut and 85% of wheat.

As a parastatal organization, the scheme is run by a Board of Directors on which tenants and employees are represented. The Board's policy is executed through four administrations, namely: the Agricultural, the Financial, the Engineering and the Administrative Affairs Administrations. The Agricultural Administration which is responsible for the field management and provision of agricultural services, is divided into 14 administrative units each covering approximately 150,000 Fed and 7 agricultural services departments one of them being crop protection.

Prior to 1965, crop protection and pest control measures were run by three bodies:

- Specialists from the Gezira Agricultural Research Station who passed their advice and recommendations to the Sudan Gezira Board (SGB) management.
- Package dealers who contracted the scheme to protect the crop, provided the pesticides and did the application.
- Specialists from the Plant Protection Directorate of the Ministry of Agriculture.

Due to the increasing toll of pests and diseases and the failure of the practices adopted, the SGB management decided, in 1965, to have its own crop protection department to be responsible for all crop protection and pest control activities in the scheme in coordination with other departments inside and outside the scheme. The department is now run by a manager at the headquarters while 14 entomologists, (M.Sc. holders) 45 assistants (B.Sc. holders) and about 300 scouts (High Secondary School) execute the department policies and activities at the field level in the 14 groups. A spraying technique section within the department is under establishment while plans are under way to set up sections for pathology, herbology, pesticides and invertebrate pests.

*1 Fed = 1,038 acres = 0.42 hectares

PESTICIDES USE IN THE GEZIRA

Cultivated cotton is well known to be vulnerable to attacks by a large number of insect pests throughout all stages of its growth. Pearson and Maxwell-Darling (1958) enumerated about 150 species attacking cotton in Africa, south of the Sahara. However, in the Gezira, 15 species are reported as economically significant.

From the early days cotton was attacked by insect pests in the Gezira and control measures had to be implemented. At that time, cultural and phytosanitary practices and resistant varieties were relied on to reduce insect pest damage.

The first attempt to introduce pesticides was in 1941 when Bordeaux mixture was first used to control jassid, *Empoasca lybica* De berg. The yield increase (11%) encouraged expansion in pesticide use. The use of synthetic pesticides started in 1944 when DDT was first tested, a few years after its discovery, and yield increases of up to 40% were obtained. This was soon followed by the use of Lindane and Dieldrin.

Cotton area treated with DDT increased from 1650 fed in the 1945 to 1946 season to 182,000 by 1951 to 1952, to cater for jassid. Later on parathion mixed with DDT was used. Endrin was introduced experimentally in 1954/55 and in 1958/59 was applied commercially on an area of 16,000 fed and increased in subsequent seasons. Dimethoate was tested in 1960 for whitefly, *Bemisia tabaci* Gen. control and its commercial use expanded during the 1960s. In the subsequent seasons many chlorinated hydrocarbons and organo-phosphorous compounds were tested, registered and released for commercial use.

The intensification and diversification of the cropping system in the 60s and 70s increased the range and intensity of pests. Carbamates were introduced, and new crop protection strategies adopted. A Crop Protection Department with scouting teams to survey pests and determine economic thresholds was established. Pesticides were applied on the basis of those thresholds instead of resorting to calendar spraying. But in spite of the progress made and the resultant positive response,

during 1966-70, yields and quality of cotton started to deteriorate and the number of sprays to increase. To overcome this situation, the package deal system was reintroduced. But after initial success, the strategies adopted resulted in low yields, poor grades and mounting costs of production. To remedy the situation, in 1980 the following measures were recommended:

- Stop the package deal
- Banning the use of DDT and DDT mixtures
- Banning the use of monocrotophos and phasing out dimethoate
- The first spray to be delayed as long as possible and resorting to selective spraying particularly at the beginning of the season
- Improvement of pesticide application through proper calibration and close supervision of the operations
- Regular checking of the physical and chemical properties of pesticides at the port of entry and in stores
- Improvement of the storage facilities, to prevent deterioration, misuse and environmental pollution.

Some of these measures were implemented but others were not fully implemented due to financial constraints. In spite of notable improvement, the control of pests still constitutes the major item and amounts to about 30% in the total cost of production.

Other crops in the rotation do not receive intensive chemical control. Wheat is sprayed 1-2 times per season. Groundnut and sorghum are not treated. Vegetables are sometimes sprayed but unfortunately sometimes the application is inappropriate, but attempts are being made to educate the farmer.

Rodenticides, fungicides and seed dressers are in common use. Zinc phosphide is the major rodenticide used but more recently the anti-coagulant Klevat has been introduced. Warfarin is used domestically. Mercuric compounds mixed with Heptachlor are the major seed dressers for cotton seeds. More recently Bronopol has been introduced but a suitable alternative to Heptachlor has yet to be tested and evaluated.

Compared to insecticides, the use of herbicides is more recent. Though the first attempts to use herbicides were made in 1946-49, when MCPA and 2,4-D were tested, the need for herbicide use became acute later on with the increase in cultivated area and the rising cost of hand weeding. Pre-emergence herbicides were tested and first commercially used in the 1975/76 season. By 1980 a large number of herbicides were screened and some were released and registered for commercial use. Currently the whole cotton area is treated annually with herbicides. The strategy adopted for herbicide use depends on:

- Timing application with the availability of irrigation water to avoid losses due to volatalization
- Use of different herbicides in rotation to avoid dominance of certain species; and
- More recently, the use of mixtures of herbicides.

REGULATIONS GOVERNING PESTICIDES USE

Pesticides entry and use in the Sudan is regulated by the Pesticide Act of 1974. Several official bodies are involved in the implementation of this Act.

- The National Pesticides Committee responsible for issuing regulations pertaining to registration, importation, distribution and manufacturing.
- The National Pests and Diseases Committee which regulates research on crop protection and passes recommendations for the use of pesticides and seed dressers.
- The crop husbandry committee which regulates research on herbicides.
- The quality control laboratory.
- The residue analysis laboratory.

Pesticides are required to pass through a period of preliminary registration before experimental screening. At this stage the pesticide is evaluated for its toxicity impact on the environment and the health hazards involved. The data are provided by the producer but information from other sources like the EPA and others is considered. The pesticides are then screened for a period of 1-4 seasons. Insecticides are first tested on a smallscale then on a large-scale. Herbicides go through primary and secondary screening trials, macroplot trials, residual effect trials and large-scale trials. Fungicides go through green-house screening and field evaluation. The results of the screening are then submitted to the relevant committee for scrutiny before use and registration for commercial use. For insecticides, it is further required to pass one season in a limited commercial scale. Currently there are over 300 products and mixtures belonging to some 16 chemicals groups and supplied by about 30 manufacturers.

Marketing is done through local agents. The scheme management is responsible for procuring and applying pesticides for the tenant. Purchase is through an international tender system processed by several high level committees.

Local formulation plants have existed as an idea since 1957 but only one such plant, owned by Shell Chemicals, is currently operating.

SAFETY PRECAUTIONS

Delivery and storage are receiving a lot of attention. The proper storage of pesticides in the open air is responsible for loss in active ingredients estimated at 10%. The Gezira weekly newspaper and television are used to address tenants on pesticide usage.

Safety precautions include first aid kits and protective clothing as well as regular medical check-ups for plant protectionists. Pesticide samples are analyzed routinely to check their properties and their safe use is supervised by well-trained crop protection

department staff. The residue analysis laboratory checks for residues in the soil, drinking water and food items.

APPLICATION OF PESTICIDES

Cotton production in the Gezira witnessed profound changes in methods of pesticide application.

Ground application of pesticides by tractors started in the 1945/46 season, in an area of 1,650 Fed at volumes of 450 l/Fed. Landrover exhaust pipes were also used for drift spraying. This ground equipment was later found to be inefficient due to its low daily output, inability to work in wet conditions and causing soil compaction and crop damage.

To overcome these problems, aerial application was introduced in 1948/49 and an area of 2,000 Fed was sprayed by helicopters. The flatness of the Gezira, the regular layout of fields and their large size provided suitable conditions for aerial spraying. Helicopters were soon replaced by fixed-wing aircraft which have been in use since 1950/51. Both methods of application used to be carried out by crop protection services contractors who would sell and apply the pesticides as a package deal. But in 1960/61 tenders were called out for the aerial application of pesticides. With the establishment of *Heliothis* as a major pest in 1962/63, season aerial application was found to be the most efficient technique. Ground application stopped gradually.

During the 60s serious outbreaks of *Heliothis* called for quicker methods of control. ULV formulations were tested, then introduced for the first time in 1973/74. The AU 3000 Micronair was used first and in 1980/81 the AU 5000 Micronair came into use. It has the advantage of spraying different formulations, ULV, EC, WP, without major adjustments. Turbo engine aircrafts with high daily output and fuel economy are now replacing piston engine aircraft. About 75 planes spray the cotton area for 5 spray rounds annually and wheat for two. The performance of aerial application contractors is continuously reviewed and checked. Work at air strips and fields is closely supervised and proper calibration and certification of all aircraft and spraying systems is mandatory before they are granted permission to operate. Heavy penalties and fines are levied for delay in spraying or negligence that leads to loss of chemical or crop damage, and it is required that spraying be done only at the optimum weather conditions.

International experts on spraying technology come to Sudan annually to train local people in improved aerial application methods.

With the increasing cost of pest control many experts believe that the use of high clearance tractor-mounted sprayers or hand-held applicators should be investigated so that application can be done by the farmer himself at less cost and less drift and pollution. But applying pesticides using small applications in an area of 500,000 Fed of cotton, under attack by different types of insects for six months a year, is tremendously labour-intensive in a country experiencing labour shortage. Moreover such change requires investment in new machinery and would involve certain cultural practices that can hardly be justified. Knapsacks, Ulvas and electrodynes are being introduced gradually to the tenants for pesticides against pests of vegetable crops which are grown usually in small fields.

EVOLUTION OF INSECT PESTS IN THE GEZIRA

Changes, sometimes dramatic, in the relative importance of cotton pests witnessed over the years in the Gezira, have been remarkable. Thus in the early days of the scheme, termites *(Microtermes thoracalis)* Sjost; flee beetles *(Podagrica punticollis* Weise, and *P. pallida* Jacoby) and thrips, (*Caliothrips impurus* Pr. and *C. sudanensis* Bagn and Cam.) were the dominant pest species. Later on, during the 1920s only thrips and beetles became the major pests.

The pink boll worm, *Pectinophora gossypiella* (sound), was also one of early pests appearing in the Gezira after its introduction into the country through imported cotton seeds from Egypt, where it had inflicted serious damage in Tokar Delta. However, with the enforcement of strict cultural, legislative and seed treatment measures, its threat in the Gezira was curbed.

Jassid, *Empoasca lybica* De berg, which was insignificant in the previous era, assumed the status of a major pest during the 1940s and through the 1950s.

The African boll worm *Heliothis armigera* Hub which was sporadic in 1930s and 1950s, became a major pest from the early 1960s through the 1970s.

The whitefly, *Bemisia tabaci* Gen., was recognized as a vector of the viral leaf-curl disease of cotton, as early as the 1930s when the disease was at its peak. The problem was brought under control by the use of resistant cotton varieties and other cultural methods. Serious outbreaks were later reported in 1952/53 but the problem became really acute during the 1960s and 1970s. This insect lowers the yield by feeding on cotton plants, but the most serious damage is the contamination of the lint by the copious 'honey-dew' secretion that interferes with ginning and spinning.

Aphids, *Aphis gossypii* Glover, were important during the 1960s, causing lint stickiness like the whitefly. The leaf worm, *Spodoptera littoralis* Boisd, increased in the late 1970s to early 1980s.

Further changes in the insect pest complex started in the early 1980s with the whitefly and African boll worm decreasing, and jassid increasing in significance, and the aphids, *Aphis gossypii*, reappearing.

The factors underlying these changes over the years are no doubt complex and analysis is difficult because they often operate concurrently. However, the following main factors stand out:

- The great expansion in the area under cotton plantation over the years.

- The diversification and intensification of the cropping system, including the introduction of new crops that provided suitable host plants for certain pests. Thus the emergence of *H. armigera* during the 1960s is partially associated with the introduction of groundnut in the rotation (Balla, 1982). Increased problems with weeds in the 1960s and 1970s sharpened the whitefly problem. The large-scale use of herbicides over all the cotton area since the early 1980s has helped to relieve the whitefly pressure.

- Changes in the cultural and agronomic practices, like the use of nitrogenous fertilizers, which increases the populations of leaf sucking insects. The positive correlation between the nitrogen level and the incidence of *B. tabaci* and *E. lybica* is well documented (Joyce, 1959, 1961; Proctor, 1962, 1963; Hussein, 1965).

  Early sowing of cotton to achieve higher yields and better grades was made possible when the use of varieties resistant to the black-arm disease, caused by the bacterium *Xanthomonas malvacearum*, coupled with phytosanitary measures were adapted. Early grown cotton is more seriously infested with *H. armigera*.

  Cotton varieties vary in susceptibility to insect pests damage. In general, medium staple varieties like Barac, are more prone to damage by *B. tabaci* and *H. armigera* than the long staple varieties like Barakal (Balla, 1979). The expansion of the area under the medium staple cotton (about 1/3 of the total cotton area) aggravated the problem of these two pests.

- Application of insecticides to control major pests has many adverse effects, but of particular interest here are the effect of DDT on whiteflies. DDT, which is used to control jassid and African boll worm, has a low efficacy on whiteflies and tends to enhance the fecundity of females greatly. This explains the 'flare-up' of whiteflies in the wake of DDT application. Again the dependence on one proprietary compound like monocrotophos coincided with the increased importance of the cotton leaf worm, *S. littoralis*.

- Environmental factors, particularly rainfall, have a profound effect on the annual abundance of insect pests. Heavy rains, especially at the beginning of the season (June-July), favour the build-up of whiteflies and African boll worm, because of the abundance of alternative weed flora where these pests multiply before they move to cotton. On the other hand, heavy rains suppress the jassid. The dominance of jassid and the decline in *B. tabaci* and *H. armigera*, over the last few years is associated with the dry weather experienced.

  Wheat in the Gezira is attacked by the two aphid species *(Rhapalosiphum maidis* and *Schizaphis graminum)* and the stem borers *(Chilo partellus* and *Sesamia cretica)*. The annual abundance of aphids is dependent on the prevailing weather conditions particularly temperature. High infestations are associated with low winter temperatures and vice versa.

THE ECOLOGICAL AND ENVIRONMENTAL IMPACT OF PESTICIDE USE

Insecticides are valuable in pest control. However, their use is attended by numerous ecological and environmental problems. In the Gezira, pesticide use has been going on for several decades, and this has undoubtedly resulted in the accumulation of pesticides in the environment. Zorghani and Abbadi (1978) estimated that not less than 2×10^4 tons of pesticide active ingredients are deposited in this area during the spraying season. Though the various ecological and environmental effects of pesticides in the Gezira have not been thoroughly investigated, the following instances where pesticides application has posed ecological and environmental problems can be pointed out:

Effect on natural control agents. The disruptive effect of increased insecticides use over the years is evident. In 1934-35, before chemical control was introduced, *Hebothis* parasites accounted for over 50% kill in the pest population in February. After the use of insecticides up to about 1955/56, the percentage parasitism declined to 1% in February reaching 39% in March. During the 1970s and 1980s no parasites were recorded. This reduction in parasites is implicated as a contributing factor in the rise in the whitefly infestations during the 1970s.

Insect resistance to pesticides. The status of insect resistance to various pesticides in the Gezira has not been investigated in detail. However, the failure of monocrotophos to control whitefly was later proved to be due to the development of resistance to this chemical. Resistance is strongly implicated in the failure of domethoate to control the whitefly. The extensive use of chlorinated hydrocarbons against cotton pests has resulted in the development of resistant malaria vector, *Anopheles gambiae*, in the Gezira (Haridi, 1975).

The control of cotton pests in the Gezira is dependent on insecticides mixtures and rotation of these mixtures. Insecticides suspected of resistance are banned, as in the case of monocrotophos, or their use is restricted to the period when the pest in question is very low.

Health hazards. In a sample of occupationally exposed persons in the Gezira, it was found that the concentration of DDT residues ranged between 0.10 and 1.01 ppm (El Zorgani and Musa, 1976). Samples of human blood from Wad Medani Hospital showed the presence of DDT residues in the range of 0.04-0.82 ppm (Abbadi and Basta, 1977).

In spite of this, however, incidences of acute poisoning are quite rare. However, more extensive studies on the impact of pesticides on human health are required. The extent of residues on food stuffs should be investigated further.

FUTURE OF PESTICIDES USE IN THE GEZIRA

From mid-1970 to the early 1980s, cotton yield and quality deteriorated due to several factors. This period which was characterized by increased insecticides applications (Table 1) was described by the FAO/UNEP Panel of Experts on IPC, in 1980, as 'crisis phase rapidly approaching the disaster phase'. Since then there has been progressive improvement in the pest situation, yields have increased, the quality improved, and the average number of sprays declined

TABLE 1
THE EFFECT OF RAINFALL LEVELS ON WHITEFLY AND JASSID 1980-85

	Pest										Total annual rainfall (mm)
	Jassids per 100 leaves					Whitefly per 100 leaves					
	Sep	Oct	Nov	Dec	Jan	Sep	Oct	Nov	Dec	Jan	
Season											
80 81	29	4	1			103	228	985	1565		282
81 82	16	14	1			45	132	399	686		243
82 83	23	28	3			8	42	174	338		181
83 84	52	24	5	7	8	41	133	259	313	457	168
84 85	40	36	18	15	24	4	21	98	166	228	51

(Table 2). Several factors are responsible for this improvement. Improved agronomic practices like early and proper sowing, better land preparation, better weed control and better water management, played a role. Furthermore, the banning of DDT, improved aerial application methods and abandoning the 'package deal' practice of relying on a single insecticide have resulted in more efficient use of chemicals. Socio-economic changes gave higher incentives to the farmers and led to better performance in the various farmer-conducted operations.

However, further improvements are required for more satisfactory pest management with less insecticides applications.

As summarized below, long-term research programs are geared towards integrated pest management (IPM) approach, but insecticides will continue to play an important role within the context of IPM. Proposed research programs within the IPM context.

TABLE 2
AVERAGE NUMBER OF SPRAYS AND AVERAGE YIELDS IN *K PER FED (1966-85)

Season	Av. No. of sprays	Yield K.P.F.
66/67	4.000	4.406
67/68	4.800	4.500
68/69	4.900	5.312
69/70	5.900	5.267
70/71	4.020	5.271
71/72	5.020	4.984
72/73	6.280	4.081
73/74	6.270	5.055
74/75	6.400	4.600
75/76	6.260	2.706
76/77	6.830	3.654
77/78	8.100	4.294
78/79	9.250	3.274
79/80	8.870	2.661
80/81	8.300	2.308
81/82	6.780	3.881
82/83	5.110	4.699
83/84	5.456	4.930
84/85	4.2	5 (Expected)

*K-Kentar = *315 lb seed-cotton*

Breeding for crop resistance to insect pests

Breeding for crop resistance to leaf-curl and bacterial blight in Sudan cotton varieties has successfully demonstrated the potential of this method. Earlier attempts to adopt a similar approach for insect pests were less successful. More recently an okra-leaf variety, Sudac-K, which is more tolerant to *B. tebaci*, has been produced. However, this variety is more susceptible to jassid, a pest currently increasing in importance.

Pheromones. Several insect pheromones were evaluated for different pest species, e.g. *H. armigera*, *S. cittoralis* and *P. gossypiella*, on cotton, and stem-borers, *S. cretica* and *C. partellus*, on cereals. In case of *S. cittoralis*, *P. gossypiella* and the stem-borers, the results were encouraging. However, for *Heliothis* the pheromones were not attractive to males.

Use of microbial agents. Trials on bactericides like *Bacillus thuringiensis* for boll-worm control met with little success. Work on new strains is planned.

Biological control agents. Though various natural parasites and predators of the major pests of cotton and other crops have been identified, more detailed studies on the biology and ecology of these beneficial insects are required. Currently some investigations on the biology and ecology of the predator, *Chrysopa carnea*, which is noticeably abundant even under the spraying regimes practised, is underway. More intensive work on the biological control agents is planned since it is only by furnishing such detailed information that their role in the ecosystem can be

enhanced.

Studies on the selectivity of various insecticides on *C. carnea* and the whitefly parasites, *Encarsia lutea* and *Eretmocerus mundus*, are going on. It is hoped that these studies will yield information to aid in the selection of insecticides with the least disruptive effects.

Economic thresholds. Economic thresholds have been determined for the major pests of cotton and are used as a flexible guide for application of chemicals. However, they should be revised in the face of the mounting cost of pesticides.

Impact of pesticides on the environment. Research in this area will be intensified with particular emphasis on the fate of pesticides in the environment, their effects on soil micro-organisms and exposure hazards to the human population.

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Pesticide Importation Strategies in Post-Independence Mozambique

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INTRODUCTION

Pesticides represent a large foreign exchange expenditure for Mozambique. Pesticide importation costs have averaged about 11 million US dollars annually over the past 5 years, having peaked in 1980 at nearly 20 million dollars. Insecticides currently account for about 40% of total expenditure and herbicides for about 40%. About one third of imported pesticides are used on cotton; pesticides for sugarcane, rice and maize account for most of the remainder. At present, over 90% of these are used by large estate and private farms, but small family and private farms are using them more and more principally in the cotton growing areas of the north, the Limpopo Valley Irrigation Scheme, and the horticultural green belts of the major cities.

Due to the lack of local pesticides formulation and package facilities, nearly all pesticides are imported as formulated products in final retail packages. Small quantities of emulsifiable concentrates are formulated in the Boro industrial plant near Maputo, and there are plans to greatly expand local formulation capacity. Nevertheless, organizational and technical difficulties with local formulation mean that Mozambique will probably continue to rely heavily on importation of formulated products. Thus, strategies to reduce pesticide import costs are very important in saving badly needed foreign exchange.

Another important consideration in determining efficient importation strategies is the ability of the government to control efficacy and quality, labeling and packaging, and toxicity. Human and financial resources for pesticide control are very limited; for example, at present there is only one Mozambican plant protection specialist trained at university level. There is very little research on pesticide efficacy, and official control recommedations are mainly adapted from those of neighboring countries with similar climate and pests.

PESTICIDE IMPORTATION AND DISTRIBUTION

At the end of the colonial period, more than 1,000 brands of pesticides were registered, of which over 300 were imported regularly. More than 50 different bodies including local and multinational agrochemical companies, agricultural supply firms, farmers' co-operatives and large private farms, were licensed by the colonial government to import pesticides into Mozambique.

Shortly after independence in 1975, one of the existing licensed importers, BOROR COMMERCIAL, was nationalized and designated as the sole licensed importer and distributor of pesticides in Mozambique. In 1978, with the creation of the Ministry of External Trade, BOROR was divided into two companies: INTERQUIMICA E.E., a state company responsible for the import and export of pesticides and other chemicals, which is answerable to the Ministry of External Trade, and BOROR DISTRIBUIDORA, a state company in charge of country-wide distribution and retailing of pesticides and other agricultural inputs, responsible to the Ministry of Agriculture. In 1983, BOROR DISTRIBUIDORA was further divided at provincial level. Nearly all pesticides are sold directly through BOROR outlets to large commercial farms. In some areas, small private and family farmers receive pesticides through the Secretary of State for Cotton or the Provincial Directorates of Agriculture.

Since 1975 importation of pesticides has been regulated by an annual national plan, compiled by the Ministry of Agriculture on the basis of requests from managers on large farms, as well as others such as the Secretaries of State for Cashew and Cotton. The selected pesticides are ordered through BOROR, which supplies any it has in stock and requests INTERQUIMICA to import the remainder. This system has resulted in a slight reduction in the number of different pesticides imported: in the period 1980-1984 about 290 different brands of pesticides were imported on a commercial scale, corresponding to 140 different active ingredients.

Unlicensed importation

Mozambique does not currently have the infrastructure necessary to prevent unlicensed importation of pesticides, but only INTERQUIMICA is allocated foreign exchange specifically to import pesticides, thus restricting pesticides importation by other means. Some pesticides are imported by certain aid projects and farms with independent sources of finance, and very small amounts are imported in unofficial cross-border trade by family farms, but the quantities involved are apparently unimportant.

SAVING FOREIGN EXCHANGE BY IMPORTATION THROUGH INTERNATIONAL TENDER

Off-patent pesticides

INTERQUIMICA purchases off-patent pesticides by calling for international tenders for the desired formulation in the desired size and quality of packaging. Tenders are solicited worldwide, from both basic producers and formulating companies. In practice most quotations come from Europe and

South Africa.

In 1981/82 a comparison C+F tender prices for three representa ive pesticides: Dichlorvos 500 g/L EC, Malathion 2% dust and Lindane 20% WP, shows that prices quoted for similar formulations of the same active ingredient can vary up to 6-fold. Package size and transport costs appear to have relatively little influence on quoted prices. On the other hand, the provision of credit can have great influence on prices: since 1978, nearly all Mozambican pesticide purchases have been made on 360-day credit.

The actual C+F prices paid by Mozambique for three representative pesticides: Diazinon 600 g/L EC, Mancozeb 80% WP and Atrazine 500 g/L FW in the years 1975-1984, show that prices have risen relatively little over the past 10 years, due to the competition through the tenders.

Extending the tender system to patented pesticides

Pesticides under patent, produced by only one company, cannot be purchased through tender and can be very costly. How is it possible to save money on the purchase of these pesticides? In many cases, it may be possible to identify two or more active ingredients with very similar effects at their respective recommended dosages (e.g. two pyrethroids for cotton pest control), and allow them to compete against one another in the tender.

In 1984, an experiment was carried out with the importation of alachlor and metolachlor (similar grass-killer herbicides, the older of which is formulated by many companies and the other by only one). In previous years, both active ingredients had been requested by farms and separate tenders were made. In 1984, requests for the two different pesticides were amalgamated and a single tender called for metolachlor or alachlor, in the required quantities (they are applied at different rates). As a result, average prices quoted for *both* active ingredients dropped significantly from previous years, and in the case of metolachlor the price per kilogram of active ingredient fell to nearly half that of the previous year, through the introduction of a new, more concentrated formulation.

The Mozambican Ministry of Agriculture hopes to expand upon this principle of competition between different active ingredients with equivalent effects, by producing a national pesticide formulary which groups together those pesticides which may compete in the tender for each use and user category. The planned adoption of a formulary would restrict the choice of pesticides to the safest and most economical products registered for each use: off-formulary pesticides could then only be imported by special permission of the Ministry of Agriculture.

Clearly, in many cases different active ingredients cannot be considered to be exactly equivalent, and decisions on importation must be based on a complex analysis of relative costs, efficacy and other properties. This is one of the functions of the Technical Committee on Pesticides.

Problems with the tender system

In theory, the system of importation through tenders allow Mozambique to import the cheapest products available, and thus to save much-needed foreign exchange. In practice, however, many other factors influence the choice of pesticides in the tender, so that it is not always possible to buy the cheapest product on offer. These include the availability of credit, problems of quality control, the provision of technical assistance with application and individual farms' loyalties with regard to formulation types and brands.

Quality control. At present, Mozambique has no pesticide quality control laboratory, and very few determinations of quality are carried out. (In a few cases, samples have been sent abroad for analysis after problems have arisen in the field). In order to ensure high quality, INTERQUIMICA normally seeks the protection of a well-known brand name, whether or not it is the cheapest product on offer.

The new registration scheme seeks to improve quality control by requiring detailed specifications of composition, certificates of analysis, and samples of the technical and formulated product to be submitted with applications for registration. By providing a sound legal basis for quality control and prosecution of offenders, the scheme will allow tenders to be opened up to more firms, thus leading to significant savings through increased competition. It is hoped that resources will be made available to set up a quality control laboratory within the next few years.

Need for company technical assistance. Due to the shortage of trained Mozambican staff, application of agricultural pesticides is frequently supervised by pesticide company technical representatives. Larger farms using aerial application are particularly dependent on company personnel for the specialized tasks of calibrating the spray planes and checking application accuracy. Many areas are served by only one representative, who is clearly in a very strong position to promote his company's products. Furthermore, the farm managers interest in ensuring continuity of company technical support from year to year provides a strong motivation for them to maintain or intensify orders of products from the locally-dominant company. A government training program is projected with the aim of alleviating the drastic shortage of Mozambican staff trained in pesticide application and thus enabling farms to freely choose the best and most economical products.

Farm loyalties. Frequently, there is a conflict between the freedom of choice of pesticides by individual farms and national needs to minimize foreign exchange expenditure. For example, it may be advantageous from the point of view of the state to import wettable powder formulations rather than suspension concentrates, because they are about one third cheaper per kilogram of active ingredient. However, wettable powders may be difficult for farms to apply (through lack of the proper equipment for agitation of the spray mixture), or simply being inconvenient to mix. How should this conflict in priorities be resolved?

In Mozambique, farms were given great liberty of choice until the early 1980s, with the result that total expenditure on pesticides soared (1980 expenditure was three times that of 1977) and very large stocks of unwanted pesticides accumulated in BOROR DIST-

RIBUIDORA warehouses. In response to this situation, an informal committee of plant protection and pesticide specialists was set up in 1982 to analyse pesticide requests before authorizing importation. The managers of the largest farms, or their representatives, are called in annually by this committee to discuss their requests and the possibilities of substituting some products with pesticides which exist in national stocks, which can be formulated locally, or are simply cheaper or safer than those originally requested. The final decision on the pesticides to be imported is taken by the National Director of Agricultural Technology, but in cases of serious disagreement, the farms' original requests are normally honoured. So far, this system has worked fairly well, and it is due to be formalized in April 1985 with the creation of a Technical Committee on Pesticides. This committee, with representatives from agriculture, health and industry, will both analyze requests from farms and adjudicate pesticide tenders.

Education and good labeling practices are very important in increasing farmer understanding of, and collaboration with, the national importation system and the pesticide formulary. For example, projected legislation on pesticide labeling will require labels to give prominence to the name of the active ingredient. Close communication between the Ministry of Agriculture and farms is fundamental to ensure good cooperation.

OTHER CONSIDERATIONS

Pesticide registration

Pesticide control laws and a rudimentary registration scheme have existed since 1963. However, in practice, registration has been a mere formality, since no application has ever been refused. The information submitted with requests for registration has generally been very scanty, sometimes being limited to a single illustrated publicity sheet of the type given to farmers. Efficacy testing is rarely carried out, and in several cases substantial economic losses have resulted from the large-scale importation of pesticides which turn out to be ineffective under Mozambican conditions.

For these reasons, a new pesticide registration scheme, based on FAO guidelines, has been drawn up and should come into operation in April 1985. Enforcement of the scheme is expected to be quite effective, despite the extremely limited resources available for this task, due to the existence of the above-mentioned single licensed importer and distributor.

Packaging and labeling

Most pesticides are imported in their final retail packages, and special requirements for labeling and packaging can be specified at the time of tenders. Transport and storage conditions in Mozambique are generally extremely poor, so that BOROR DISTRIBUIDORA has for the past few years demanded extremely strong packaging (e.g. bags of powders must be overpacked in steel drums). In the past, BOROR also required insecticide drums to be painted red, herbicides green and fungicides yellow. The Ministry of Agriculture is presently considering modifying this policy and requiring drums of highly hazardous pesticides to be painted red, in an attempt to easily identify and prevent reuse for household purposes.

A comprehensive pesticide law, including provisions on packaging and labeling, should come into force in late 1985.

Pesticide import statistics

Collection of pesticide import statistics is vital for long-term planning and decision-making. In Mozambique, collection of statistics with regard to officially-licensed importation is relatively simple. For each importation, INTERQUIMICA fills out an importation bulletin which gives basic data on the pesticide, its producer, and the total and unit prices paid in foreign and local currencies. This bulletin must be signed by the Ministry of Agriculture before the pesticide can officially enter the country. Data from these bulletins are collected annually.

NOTE: The views expressed in this paper are the responsibility of the first author. Many of the points raised are still under discussion in the Mozambique Ministry of Agriculture.

Pesticide Use in East and Southern Africa — An Overview

by
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ABSTRACT

Pesticides are used in East and Southern Africa to control a variety of vectors and agricultural pests. This paper gives an overview of the quantities of pesticides used in the region and on which crops. Descriptions of who uses pesticides, what pesticides are available, and the distribution system for pesticides in the region are included. Types of application, pesticide legislation, and aid pesticide donations are discussed from a regional perspective.

INTRODUCTION

Pesticides are used in East and Southern Africa for the same reasons they are used elsewhere — to control pests. These pests can be agricultural pests or disease vector pests, for both animals and man. For agricultural pests, pesticides are used to preserve the benefits of increased production. For vector pests, they are used to save lives and prevent diseases.

The region, however, seems to have more than its share of common pests: insects, plant diseases, weeds, rodents, as well as most of the plagues known to man; the African armyworm, locusts, grain eating birds, and droughts.

THE NEED TO CONTROL PESTS

With a population growth rate of 4% in some countries of the region, an agricultural miracle is needed for Africa to feed its people and the soil cannot afford any food losses through pests. In Sub-Saharan Africa, per capita food production has actually declined a shocking 1.1% a year. (Mellor and Adams, 1984).

Faced with food shortages, most countries in the region have come to rely on greater food imports using the scarce foreign exchange. In drought-stricken Sub-Saharan countries, food imports have increased an average of 9.2% a year. (Mellor and Adams, 1984).

Where does pesticide use fit into the picture? As said before, you control pests to preserve the benefits of increased production. Pest control does not necessarily mean the use of pesticides, but rather the use of good pest management practices. But since the topic of this paper is pesticide use in the region, I will keep the focus there.

HOW MUCH PESTICIDES ARE USED

To date, the leading African agro-chemicals consumers are countries with a well-developed cash-crop sector, especially those where the bulk production takes place on plantations, large farms, or centrally administered schemes. In a study done in 1981 which evaluated agro-chemical use in Sub-Saharan Africa, the countries listed in table 1 were the big users.

TABLE 1
EXPENDITURES ON AGRO-CHEMICALS IN SUB-SAHARAN AFRICA

Country	$ Millions
Sudan	52.7
Tanzania	31.8
Zimbabwe	29.4
Cameroon	24.2
Ivory Coast	19.4
Kenya	12.0

Source: Bryant, 1984

WHAT CROPS ARE PESTICIDES USED ON

The figures given in table 2 reflect the nature of the different cash crops grown in the region. Cotton — notoriously difficult to grow — accounts for 40% of agro-chemicals used in Sub-Saharan Africa.

TABLE 2
EXPENDITURE ON AGRO-CHEMICALS BY CROPS IN SUB-SAHARAN AFRICA

Crop	$ Millions	% of total
Cotton	108.7	40
Coffee	40.8	15
Cocoa	35.7	13
Maize, tobacco, bananas	11.0	4
Sugar	10.0	3
Rice	7.0	2
		7

Source: Bryant, 1984

NON-CASH CROPS

The food staple crops in the region are composed mainly of maize, sorghum, millet, rice, beans, cassava bananas, and wheat.

White maize *(Zea mays)* is far and away the most favoured staple food crop in the region, and the crop

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grown most by subsistence farmers for their own food.

Although each of the above food crops has its own pest problems, for the sake of simplicity, we will focus just on maize, its associated pests, and the pesticides most commonly used on maize in the region.

The major pests of maize are summarized in table 3. It should be remembered that this list is a composite from several reports. The severity of the damage by each pest in each country varies tremendously.

TABLE 3
MAJOR PESTS OF MAIZE

pre-harvest	stem borers army worms leaf hoppers cut worms seed decay rodents weeds
post-harvest	weevils grain-eating birds borers molds

Source: FAO Survey Reports on Zambia, Kenya, Mozambique, Somalia, Ethiopia, Sudan, and Uganda.

Maize crops are plagued by the usual insect and bird pests with the stem borer complex being usually the most serious. Attack can occur at any stage of crop growth but is most severe when the plants are about 15 cm tall. In normal seasons quite large borer populations occur with no detectable loss in yield, but in poor seasons, on marginal land, in out-of-season crops, or when there is a very high borer population, loss in yield can range from serious to disastrous.

For borer control, I have seen a variety of chemicals being used, including DDT applied to the stalk from a teapot, to granular Dipterex being added to the stalk by hand. Based on personal observation, the only other general use of pesticides by the subsistence farmer on maize was in grain storage. Malathion 1-2% dusts are commonly used at a 10 ppm rate.

TABLE 4
ON-FARM LOSSES IN EAST AND SOUTHERN AFRICA DUE TO INDIGENOUS STORAGE PESTS

Malawi	3-4% in 9-10 months
Kenya	3-5% in 9-10 months
Zambia	2-6% in 9-10 months
Due to *Prostephanus truncatus*	
Tanzania	9% in 3-4 months (1-35%)

Source: Golob, 1985

The larger grain borer (LGB), *Prostephanus truncatus*, has been a major problem in Tanzania, with outbreaks also reported in Kenya and Burundi. Table 4 gives an example of the on-farm losses due to indigenous storage pests and to the LGB.

The control strategy in Tanzania is: to store shelled maize; treat the shelled maize with 0.5% permethrin at a rate of 50 g of dust per 90 kg maize; store in a suitable container; do not store cassava for long periods (Golob, 1985).

WHO USES PESTICIDES

To get an idea of importance of agriculture in the region, table 5 gives a summary of the agricultural labor force in the region and the export earnings from agricultural products.

TABLE 5
AGRICULTURAL LABOR FORCE AND EXPORT EARNING IN ESA COUNTRIES

	Agricultural labor force (% of population)	Agricultural exports (% of total)
Ethiopia	79	88
Kenya	78	?
Malawi	84	95
Mozambique	64	75
Somalia	81	30
Sudan	78	95
Tanzania	81	80
Uganda	81	97
Zambia	66	15

Source: FAO reports on survey of crop protection for Ethiopia, Kenya, Malawi, Mozambique, Somalia, Sudan, Tanzania, Uganda, and Zambia.

This region is devoted to and dependent on agriculture. There is the whole range of pesticide users, from the highly sophisticated commercial farmers found in countries like Kenya, Malawi, and Zimbabwe, for example, to the so-called emergent farms using some modern farm technology found in most ESA countries, to the subsistence farmer found in every country of the region.

No figures are available on the percentage of the agricultural labor force in the region which has access to and uses pesticides. However, an educated guess can be made: commercial farmers, for sure; emergent farmers, probably; and subsistence farmers, maybe, on occasion.

WHAT PESTICIDES ARE AVAILABLE

Availability is very country-specific and foreign exchange-dependent. In countries like Rwanda, Burundi and Lesotho, only limited supplies of agro-chemicals were available. However, regional supply

centers like Kenya or South Africa can supply chemicals upon demand. In places like Zambia and Tanzania where foreign exchange is a serious problem, a wide range of pesticides are available to the consumer, but on a sporadic basis. In other countries like Kenya, Malawi, Swaziland, most or all agro-chemicals are readily available.

Organo-chlorines are still very much in use in the region, especially for vector control programs. For example, Zimbabwe uses approximately 440 tons of DDT per annum to control tsetse flies and malaria mosquitoes (Matthiessen, 1983). Dieldrin, aldrin, lindane, and even BHC, are usually readily available for both agriculture and vector control. The Desert Locust Control Organization (DLCO) still prefers the use of dieldrin for locust control over other chemicals (Abebe, 1983). DLCO has large stocks of dieldrin all over the region for its emergency locust campaigns.

A wide range of insecticides are sold in addition to the organo-chlorines with LD50's ranging from 0.9 mg/kg (Temik) to 4,000 mg/kg (Permethrin). These include the synthetic pyrethroids, carbamates, and organo-phosphates. Additionally, a wide range of weed killers, fungicides, seed dressings, rodenticides, and stored-grain protectants are usually available around the region.

The distribution of agricultural inputs including pesticides varies tremendously. In most countries in the region, distribution to the subsistence farmer is carried out by parastatal organizations. Some organizations are better than others at getting the proper inputs distributed to the agricultural areas in a timely fashion. On the other hand, other countries such as Rwanda and Burundi lack distributing organizations, so their use of agro-chemical inputs is minimal.

Most countries have major chemical company representation. The international companies most active in the region include Bayer, Ciba-Geigy, Dow, Hoeschts ICI, Monsanto, Shell, and Twiga. The commercial farmers usually purchase pesticides directly from private firms.

Then there is the informal type of pesticide distribution, it happens all over Africa, where an "entrepreneur" purchases a pesticide in bulk, then repackages it in smaller containers and sells it directly to farmers. Repackaging is usually done into non-labeled containers, sometimes even Coca-Cola bottles. This very serious problem of informal repackaging will be addressed in the detail it deserves in other workshop presentations (see David Bull — "Pesticide labeling — An NGO point of view", and Anne Stroud — "Linking government and private sector information to the farmer").

HOW ARE PESTICIDES APPLIED

Here again, the technology for application equipment varies from the use of airplanes to bare hands. Only in the areas with big commercial or state farms is aerial spraying an economically viable option. Boom sprayers are commonly used by commercial farmers. Knapsack sprayers are commonly used by the emerging farmer group with relatively small acreage. Some subsistence farmers are using knapsack sprayers, as well, but with questionable effectiveness.

How effectively are pesticides being applied in the region? Probably much less effectively than would be hoped. This response is based on a study done in the U.S. where two of every three pesticide applicators (Nebraska farmers and commercial applicators) were making significant application errors - the result of inaccurate calibration, incorrect mixing, worn equipment, and failure to read the product label (Reichenberger, 1980).

The results of this study are interesting. Over a fourth of the 95 applicators studied were over-applying by an average of 30%, while a third of the applicators were under-applying by 30%. Table 6 shows where in the pre-application process most mistakes were made.

TABLE 6
WHERE APPLICATORS MADE MISTAKES

Error	Per cent of applicators that erred	
	More than +5%	More than +10%
Calibration	49%	46%
Mixing	8%	5%
Both	30%	12%

Source: Reichenberger, 1980

Misapplications are bound to damage the pocket-book. Over-application, especially when using herbicides, can cause crop damage. Under-application of herbicides can cause poor weed control.

Although I am not aware of any similar study done under developing country conditions, I am doubtful that African farmers would fare much better.

PESTICIDE LEGISLATION

Legislation to control importation, manufacture, sale and distribution of pesticides is clearly needed in every country because of the toxic nature of the chemicals concerned, and the often complicated and far-reaching effects of their regular usage both on the health of the population and on the entire environment within the country.

Packaging, labeling, and disposal of waste containers should also be incorporated in local legislation, as should regulations concerning use of protective clothing when applying pesticides.

Based on perhaps out-dated information, the status of legislation in some ESA countries is listed in table 7.

Although many countries in the region already have pesticide legislation, I believe it is safe to say that there is no country in the region which has adequate financial and manpower resources to ensure that these regulations are strictly enforced. Africa is not alone. The same problem exists in the USA. The Environmental Protection Agency's pesticide office has a yearly budget of $56 million and a professional staff of 462 (Pearson, 1985). Even with those resources, EPA still has difficulties in ensuring strict enforcement of all its pesticide legislation. This subject, too, will be addressed in detail in other presentations during the workshop.

TABLE 7
PESTICIDE LEGISLATION IN CERTAIN EAST AND SOUTHERN AFRICAN COUNTRIES

	Legislation		Residue Analysis		
	Yes	No	Pending	Yes	No
Burundi		X			X
Ethiopia	X			X	
Kenya	X			X	
Lesotho		X			X
Malawi	X			X	
Mauritius	X			X	
Mozambique			X		X
Rwanda					
Somalia		X			X
Swaziland		X			X
Sudan	X			X	
Tanzania	X			X	
Uganda			X		X
Zambia		X		X	
Zimbabwe	X			X	

PESTICIDES IMPORTED BY AID DONORS

According to an article by Margi Bryant in the *Africa Economic Digest*, the agrochemical market is starting to hinge on the policies of international donors. Because of foreign exchange shortages and balance of payments problems in many countries, a high proportion of agro-chemical purchases — estimated by industry sources at around 80% — is now funded by aid agencies, either as program aid, commodity support or through agricultural development projects. French manufacturers, Rhone-Poulenc Agrochimie and Roussel-Uclaf, supplied nearly half of Sudan's $55 million agro-chemical requirements for 1982/83 under the financial protocol signed between the two governments that year.

One of the objectives of the workshop is to develop, as a group, guidelines for pesticide donations.

PESTICIDE DISPOSAL

Without doing a proper survey, I believe it is reasonable to assume that every country in the region has one sort of disposal problem or another. For instance, there are 50 metric tons of malathion in a warehouse in Zanzibar that no one wants. There are 5 metric tons of DDT on the island of Pemba that need to be disposed of. Even closer to home, DLCO has about 40,000 l of unwanted dimethoate which was given to them by a donor. Each person here could describe a site where unwanted pesticides are stored. And then there is the very serious issue of reuse of containers. In a study done in Zimbabwe (Bwititi, 1983), workers on commercial farms in the province of Mashonaland said that 59% of the "used" pesticide containers were used for domestic purposes such as vessels for brewing beer or for fetching water. This is, of course, against the law in Zimbabwe, but it still happens, and not just in Zimbabwe, but no doubt in every country in the region.

HOW SHOULD PESTICIDE CONTAINERS BE DISPOSED OF

Group 1 (burnable)
(Pesticides except ones containing mercury, lead, cadmium or arsenic).

Burn in special incinerators.

Burn in small numbers in the open in keeping with local regulations.

Bury in special landfill or bury deep at least 46 cm (18 inches) deep in open fields.

Group 2 (non-burnable)
Crush and bury as described for group 1 containers. If reusable, rinse three times and return to your supplier.

Group 3 (non-burnable, containing heavy metal pesticides)
Rinse three times and bury in sanitary land fill. If not rinsed, bury in a special designated land fill.

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A Pesticide Institute: Is It a Regional Need

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INTRODUCTION

Many participants have drawn our attention to several reasons why we must seriously be concerned about pesticide management practices in Eastern and Southern Africa.

On the beneficial uses of pesticides in the region, they pointed out three main advantages. First, that losses in national economies due to damage to crops by various pests, and loss of life through diseases transmitted by vectors, can all be decreased by the use of pesticides.

Second, that effective pest and vector control within the region depends on the application of appropriate strategies which at the moment are haphazard due to lack of adequate information.

Third, and perhaps most important, that in pest and vector control using chemicals, two main strategies may be adopted, namely, the preventive or eradication approach and the corrective or containment approach. The first approach is to prevent the pests or vectors from becoming important, for example, when pesticides are applied routinely as a prophylactic. The second approach would involve reducing pest and vector populations to levels where their damage is not economically significant. It was noted that in ESA countries, the factors which raise or lower the economic threshold of the most common pests were still unknown and will not be known until research to determine them is carried out.

Discussions on IPM showed that it relies upon an analysis of the biological and economic systems of both pest control and crop production. This kind of research has so far not been carried out in ESA countries. It was concluded that for ESA countries, a clear understanding of the interaction of the complex of factors operating in the ecosystem is fundamental to successful integrated pest and vector management.

Perhaps, the most disastrous effect of pesticides misuse can best be illustrated by the history of cotton pest control using insecticides in the countries of Central America. Cotton forms the backbone of the economies of Nicaragua, Guatemala and El Salvador, and together with Honduras, they produce 2% of the world's cotton. From 1949 to 1965, there were sustained increases in cotton yields due to the use of pesticides. But thereafter, as pest resistance to insecticides developed, cotton yields declined and each country suffered a severe economic crisis during 1965-70.

In Nicaragua alone, it was estimated that as a result of an annual expenditure of US$ 10 million on the importation of pesticides, there was environmental damage estimated at US$200 million per annum. Losses came in the following forms.

- Presence of residues in terrestrial and aquatic biota.
- The rejection of beef exports by buyers due to excessive DDT residues.
- Human poisoning and death due to pesticide toxicity.
- Significant increase in the incidence of malaria in the cotton growing areas due to the development of resistance to DDT by the malaria mosquito vectors.
- Failure of farmers to grow crops such as beans and maize in cotton growing areas because of aggravation of pest problems due to the heavy use of pesticides on cotton.

Regrettably, as we talk now, we do not know how much of such losses are developing or have already been incurred in ESA countries since we lack facilities or we have not embarked on activities to detect them.

ON THE NEED FOR A PESTICIDE RESEARCH AND TRAINING INSTITUTE IN ESA

The answer to the question of how best we can use pesticides so that their maximum benefits are obtained, while at the same time their adverse effects are minimized is clearly the establishment of an effective institution within the ESA region to provide relevant research and training in pesticide management.

Specifically, the institute would work on the fundamental aspects of pesticide application and behavior in relation the control of tropical pests and vectors. A number of pests and vectors such as locusts, armyworm moths, tsetse flies and simuliid black flies can be adequately controlled only with regional collaboration. The institute would be funded and fully supported by national governments, industry, international foundations, United Nations agencies and foreign donor organization on much similar lines as in the present case for the desert and red locust programs within the region.

Two distinct functions would be carried out at the ESA pesticide research institute, namely fundamental research on pesticide management and training. Research would be specifically developmental-oriented for application to pest and vector management and environmental improvement. In this regard, research programs would be mounted on pesticide

residues in foods and feeds and in the persistence and rate of pesticides. The institute would also be expected to carry out work on monitoring pest resistance to pesticides, and the susceptibility levels of the major pests and vectors.

For both functions of research and training, the institute would collaborate with national universities and other higher education institutions which have the authority to award diplomas and degrees. The institute itself would provide the research base for professional training of scientists and technologists. Apart from professional training, the institute would train field operators and organize in-service training in the form of formal lectures, seminars, study workshops, symposia, group-training and field courses for all levels of staff and even for farmers.

To foster community participation, which was much talked about at the beginning of this workshop, and which is especially important for pesticide management programs, the institute would aim to educate and enlighten the public. In addition, special seminars for administrators, politicians and policy-makers in government would be arranged. Such functions would lead to the development, application and evaluation of pesticide management strategies in both agriculture and public health, and eventually result in increased food production and a more healthy population in ESA. A feed-back mechanism would be established for referring problems of pesticide management in the field to the regional research and training institute for investigation and the application of appropriate solutions. The efficient execution of all these activities would help to achieve sound socio-economic development in ESA.

A well-organized regional research and training institute would bring about international and regional cooperation, and the exchange of information and ideas on pesticide management. Finally, the institute would typify a model of an "activity centre" for research and training in pesticide management in the ESA countries as an example in the tropical developing world.

For these reasons the answer to the question, A pesticide institute: Is it a regional need; is a firm 'Yes', to my mind. In fact, I am not alone in having this belief. For instance the FAO has recently formulated a proposal on the establishment of a Regional Pesticide Analysis and Training Laboratory in the ESA region. The proposal is under discussion. The establishment of pesticide institute in the region should therefore be considered seriously.

Considerations in Pesticide Technology Transfer to Small Farmers

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ABSTRACT

The small farmer is characterized by owning on average 3 to 4 ha, using mixed cropping systems, utilizing heterogeneous germplasm, and using very few purchased inputs such as fertilizers or pesticides. The small farming sector is also characterized by a large variability of resources, including soils and rainfall, and management of these resources; thus, a generalized form of development is not appropriate.

This paper will suggest methodology to facilitate realistic integrated crop protection strategies, both concerning pesticides and other control methods, that will be usable by the small farmer. Investigation of the traditional cropping system will give understanding of the complex management strategies, integrated control measures already used and the environmental balance inherent in this and farmer perceptions of crop management and pest control. The variable economic situation of this sector and the farmers' present strategies for dealing with this must be taken into account when trying to utilize such concepts as economic thresholds in order to tailor the concept to this situation.

Research and extension techniques must be selected for appropriateness. Technologies should preferably be tested within the farmer's system involving the farmer, and evaluation methods must include socio-economic factors. Extension workers should translate research findings into the farmers' language.

Before introducing pesticides into the small farm sector other considerations include: adequate safety; application equipment and methods; teaching farmers how to calibrate; pesticide choice; labeling and packaging, distribution, marketing and credit systems.

INTRODUCTION

Approximately ½ of the world's population, covering 40% of the land area, practices subsistence farming, using primarily "traditional" agricultural technologies (Glass and Thurston, 1978). Traditional agriculture is characterized by small farms, averaging 3-4 ha with even smaller cultivated plots; polyculture or mixed cropping systems; use of heterogeneous germplasm, perhaps resulting in different stages of crop growth in a given area at the same time; little or no use of chemical fertilizers or pesticides; and possibly use of minimum tillage with fallows, land permitting (Glass and Thurston, 1978; Farrington, 1977a). Limited infrastructure such as roads, schools, health facilities and credit facilities has contributed to relative isolation resulting in high illiteracy rates, short life expectancy, and generally low living standards compared to more developed countries. Often, environmental conditions such as little or unpredictable rainfall and poor or difficult to manage soils give the small farmer an even more limited resource base. Nevertheless, the small farm family has continued to survive by managing a complex system with limited resources.

Also inherent in the small farm sector is a large variability in resources and management capabilities coupled with complex social differences. Variations in crop yield alone are high (coefficient of variation being 50% in East Africa compared to 15-20% in developed countries) and indicative of the large variability of circumstances in the small farmer sector. (Farrington, 1977a). This lack of homogeneity makes it difficult for generalized development to have an impact. Thus, a more site-specific understanding of conditions is necessary and more relevant technologies must be forthcoming.

UNDERSTANDING PEST CONTROL IN THE PRESENT SMALL FARM SYSTEM

"Traditional methods of crop protection were developed empirically through centuries of trial and error, natural selection and keen observation" (Glass and Thurston, 1978). Methods of pest and weed control used included: host resistance, cultural controls such as crop rotation, irrigation, cultivation, time of planting, mixed cropping, fallowing, shading and biological control. An interesting example of biological control which was developed by Chinese citrus growers and used for centuries involves placing nests of a predaceous ant *(Oecphylla smaragdini F.)* in trees to reduce insect damage. The farmers put bamboo connectors between trees to encourage migration and control. (Glass and Thurston, 1978). These two authors rightly state that it is important to understand characteristics of the traditional system such as the resistance and tolerance of local crop varieties; the influence of existing cultural practices on pest population dynamics and the potential environmental impact of pesticide introduction. We will probably learn that the concept of IPM is not new. The suggested approach to pest control is to evaluate the traditional system, determine what is essential and what can be improved, and to introduce changes in a rational manner consistent with the environment.

The introduction of pesticides in peasant agriculture is relatively recent. The method has obvious advantages, especially when used in an integrated control context. In East Africa, pesticides use has initially been primarily on cash crops, about which there is more traditional research information compared to food crops, where there is often credit and supply facilities and where the farmer perceives pest damage and control as cash

expenditure related to cash income (higher yields) (Goldman, 1985).

Decision-making concerning pest management is closely linked to the farmer's perception of the pest, the damage that it does and the consequences of the damage in his terms. It is important therefore, in introducing pesticides as a control measure, to understand the perceptions of the farmer, whether right or wrong. It was found in the Philippines, for example, that farmers tended to lump certain pests together as "worms". They attributed damage to the wrong insects and did not understand the concept of resistance, so they continued to spray when it was not needed. In other cases, the farmers' perceptions were better than those of trained entomologists (Goodell *et al.*, 1982). Valid technological solutions coming from traditional research trials may not be always adopted.

Goodell *et al* (1982) documented several examples of how IPM technical assumptions concerning pest perception were changed in the course of introducing the technology to rice farmers.

Scientists' initial technological assumptions	**Technological positions after 2½ years of collaborative work with an anthropologist**
Post-season questionnaires provide reliable data on pest perception and control practices.	Ideally, farmers' pest control practices should be observed not queried. Frequent queries are better than 1 post-season survey.
Pests significant to farmers throughout a village can be specified beforehand for all practical purposes.	Unexpected pests such as rice semi looper make field trials less useful than feedback from farmers in making village level recommendations.
Rice whorl maggot is a serious seedling pest.	Rice whorl maggot is not a serious pest in isolation, but only in certain environmental contexts.
Identification of discrete pest entities and their causal relationships to yield losses are prerequisites for successful understanding and use of IPM.	Farmers perceive pests as part of a crop context, translating our cause-effect relations into contextual terms is a major challenge.

Note: Extracted from larger table.

FORMATION OF PESTICIDE USE RECOMMENDATIONS

Generally, each country must have a system for generating pesticide recommendations. Organized field testing using a step-wise, uniform methodology for various stages of development should be co-ordinated. It is recommended that an independent body (often a research branch) test the materials, while another body (a central government) gives final approval. This minimizes the possibility of dishonest arrangements between business and government. A system for coordinating industry activity and cooperation with that of the independent testing and ultimate distribution to farmers should be developed. This paper will discuss the philosophy behind the development of suitable recommendations that can be reasonably used by the small farmer.

It may be worthwhile to first look at situations where pesticide use recommendations are *not* being followed. It has been documented that small holders often spray less than recommended usually because of lack of funds or inadequate supply of the pesticide. However, farmers still do not use recommended rates where credit and supply are available. This situation is explained by a complex interaction of economics, risk, management and human nature. (Farrington, 1977 b).

In Malawi, researchers gave an economic justification for a certain application based on rate to be used calculating gross marginal returns where costs included insecticide, sprayers and labor. They found 11½ sprays on cotton per season to be optimum. In practice farmers were applying 5-7 sprays only. Upon closer investigation, it was found that in a poor rainfall year, it was more economical to apply fewer sprays; thus, partially, the farmers' reaction was to associated risk. It is generally known that increased profitability not only depends on good insect control but also good husbandry and management. The recommendations had been based on research trials with 'master' farmers who were good managers; therefore, the recommendations were suitable for this group but not for poor farmers who realize lower output for other reasons. Rainfall risk had been a neglected factor also. This risk is more of a problem for poorer farmers and because rainfall is unpredictable, poorer farmers always applied less than the recommended rates of chemical (Farrington, 1977 b).

In Makueni, Kenya, most farmers use sub-optimum levels of pesticides on their cotton crop. Payment is made in one lump sum which, unlike food crop sales, is used for larger investments. Money spent on pesticides in this situation is approximately 10% of gross earnings. Although not high, it represents the main financial input. Thus, in poor or uncertain years, money is saved by reducing pesticide expenditure. Under-usage of pesticides was the norm, the amount being adjusted by climatic conditions and expectations in yield. The number of sprays was less than recommended and the dosage per spray was one-half the amount recommended. The economic system is complex, the profit margin is small and thus the decisions on optimum use of pesticides is difficult.

The economic threshold concept simply being "maximum pest population that can be tolerated without resultant economic crop loss" has been a useful concept in developed countries to help make judgements on appropriate pesticide use. The concept has been useful to large-scale farmers where economics may be more predictable. With large volume, modern, efficient application methods, decision and implementation time is reduced; benefits and costs are predictable with relatively good certainty; information concerning pesticide use for a given situation is available. In peasant agriculture, there is relatively little information concerning

farming characteristics, yield potentials, potential losses by infestation of a given density at a given crop stage. Farrington (1977 b) suggests that plots with a lower yield potential will suffer higher proportional loss but lower absolute loss than those plots with a higher potential yield. Therefore, a threshold for lower production plots should be at a higher level. Also the cost of control measures in peasant agriculture compared to developed country agriculture is much higher relative to crop value, especially for farmers with a lower production potential. Thus, cash outlay for a small farmer may be more risky (Farrington, 1977 b). In summary, the economic outcome for the small farmer is less predictable and is affected by:

- Possible increases in marginal costs throughout the season; (cash availability changes, labor costs may rise or vary, crop growth changes; increase in needed outputs if crop successful).
- Increases in risk throughout the season due to rainfall or other variables outside the farmer's control.
- Continuous revision of yield estimate which always changes as the season progresses as well as unit price which is often determined by local markets.

The above discussion reviews the complexity of any given situation involving the small farmer's pest management decision-making including pesticide use.

TABLE 1
PROBLEMS OF REFINING IPM TECHNIQUES

Scientists' initial technological assumptions	Technological position after 2½ years
Frequent monitoring of trap and field populations is within the capacity of better educated farmers.	Light traps and most quantitative tools are tedious for farmers. The light traps are dropped and the tools redesigned to be qualitative.
Graphing of insect populations is within the capacity of better educated farmers.	Graphing insect populations is too abstract. Concrete infestations or damage levels at particular times is more usable.
Farmers' ineffective use of insecticide can be remedied by more careful measurement	Excessive frequency of insecticide applications have been reduced, but dosages are still low. Scientists have not yet developed simple methods for farmers to calculate dosages accurately
Quantitative economic thresholds for pest control decisions can be used by farmers and technicians.	Quantitative economic thresholds are not yet simple enough, qualitative decision rules are more usable.

The economic threshold can be a valuable tool, but needs adapting to the small farmer's variable circumstances, taking into account resources, economic risk and management levels. It will most likely be counter-productive to base economic threshold levels on experiments in well-managed research plots. The farmer's condition must be fully sampled with the farmer's full involvement. Farrington (1977b) suggests the need for many threshold levels determined by the varied conditions. A method of handling this would be to divide the community into homogenous groups and establish threshold levels for each group.

Goodell *et al* (1982) list several problems related to refining IPM techiques for rice farmer understanding and use.

Several researchers have documented the farmer's adjustment of research-based recommendations to their situation, as mentioned above. It is often proven, upon careful scrutiny, that it is not necessarily the farmer's ignorance, but his knowledge of his given situation, that actually gives better results. The implication for research is that recommendations need to be based on a fuller understanding of the farmer's circumstances (labor, weather, etc.). Researchers should take note of the yield gap between research stations and the farmer's field, usually due to management, resource and environmental differences (Farrington 1977 b and Cox, 1982). Thus, the farmer does not just need the "optimum" recommendations, but information on how to best depart from the optimum when economically necessary.

There is a need for the scientist to move from general, abstract and future orientation towards the immediate and concrete. Experiments must move off the experiment station onto the farmer's field and involve farmer management. "Control" or check plots must reflect the farmer's practice under farmer conditions in order to make a valid comparison. Evaluation criteria must involve the farmer's circumstances, i.e. economic considerations, acceptability, etc. One problem that may have to be dealt with is the scientist feeling that as a result of this "new" orientation his standards are being lowered compared to traditional peer expectations. However, the change must take place if recommendations are to make an impact.

CONSIDERATIONS IN EXTENSION OF TECHNOLOGY

Extension involvement can begin in the process of technology generation even prior to technology transfer. They can be involved in investigating farmers' indigenous knowledge concerning pests and their control. Extensionists may report alternative uses of pests to researchers, for example; where farmers in Zaire prefer eating mosaic leaves of cassava or in Mexico where farmers grow varieties of maize that are susceptible to smut which is harvested, eaten and if sold brings a higher price than maize itself (Kirkby, pers. comm.). Weeds also have alternative uses: as vegetables, animal feeds, erosion control, etc. (Stroud, 1983).

Extensionists can also contribute information to researchers concerning the physical environment,

social preferences and economics of any given situation. Because extensionists theoretically work close to the farmer, their understanding of these factors should be well-based. However, in actual fact, extensionists may not be working as closely with farmers as presumed, due to lack of support (vehicles, petrol, etc.), lack of motivation (low salaries, little follow-up by superiors) and lack of knowledge or observation skills. In this case, an extension management system, such as Training and Visit being used in Kenya, has certain advantages. The system, briefly, offers a farmer or group visiting schedule where messages coordinated with the crop cycle are taught or demonstrated in the field. This exercise is supplemented with organized planning and training schedules.

Extensionists can also be involved in assisting the researcher in experimental management when working under the farmer's conditions. They can assist in site selection, farmer participation, monitoring and management. The extension-research linkage is an important one to maintain as it helps extensionists understand the researcher methodology as well as the technology itself. It also helps the researcher to understand the farmer's situation and offers a mechanism for bottom-up feedback. This interaction, at least, gives more assurance that technology developed will be supported by better understanding of the user and can be more or less tailored to the situation.

A major problem faced by most East and Southern African countries is the low training level of extension staffing. Often those working with farmers, will have received only a general agricultural background in a 2 or 3-year training institution. They may be very deficient in specific, practical knowledge concerning pest control and pesticide use. This is a major deficiency which needs attention if the transfer process is to occur at all. The low staffing problem is usually worse in more difficult semi-arid areas, where farmers tend to have greater problems and larger information and back-up services deficit. As mentioned, the small farming sector is varied and the variation and small land sizes challenges the extension department as to how to place and maintain the optimum number of staff especially in view of the fact that farmer contact under their conditions is the best way to transfer technology. In some instances, central training points such as farmer training centres have been used with some success (Goodell *et al* 1982).

The actual "sale" or methods of teaching technology are also important. Obviously, the farmer's confidence must be won over. In this respect, lessons demonstrated in the farmer's field are much more believable than written leaflets, classroom instruction and efforts to prepare for the unseen. Extensionists can assist by providing feedback to researchers on technical aspects of technology components.

Considering the illiteracy rate of the small farming community, information or methods used in determining the appropriate pest control measure must be formulated accordingly. Such a method was developed in the 1970's in Malawi for use by cotton growers. A 3-color pegboard was developed to help farmers monitor for pest infestation. One color represented *Dipiropsis castanea* Hmps., the other *Heliothis armigera* Hbn. and the third, cotton plants. As pests were sited pegs were moved along. If they crossed a black line, then the farmer knew he must spray one or both chemicals (Beeden, 1972). This method is also useful in teaching farmers to be better observers and about pest biology.

The extension agent is useful in monitoring pesticide use and pest control methods in general. To do this well, they must have sufficient background and be able to perceive and understand what the farmer is doing and why. For this reason, extensionists are invaluable in both the research and technology transfer process.

OTHER CONSIDERATIONS IN PESTICIDE USE BY THE SMALL FARMER

The introduction or encouragement of proper use of pesticides must be superseded or supported considering the following factors:

Safety

Cost, suitability and availability of protective clothing must be considered. Producers of such items should be encouraged to develop low cost and suitable clothing. The problem of supply still exists however, and can be especially acute in countries such as Mozambique, Tanzania and others. In these cases, it would be advisable to: choose fairly non-toxic pesticides, application equipment that helps eliminate contact, to use trained applicators only, and safe, easy to use formulations that minimize contact hazards.

Medical assistance must be available, as accidents are bound to happen. This is often difficult as health facilities, antidote supplies and knowledge are all limited in most small farmer communities in East and Southern Africa. One solution is to train extension staff or local, responsible people to perform the basic first aid measures, but this may need extensive government or donor support to implement.

Training on safe-use methods cannot be overstressed Personnel passing messages onto the farmer, such as community leaders, estate managers, storekeepers, industry and extension, must be well aware of the proper use and storage of these materials.

Application methods

Equipment, its use and pesticide choice are major issues. As time goes on, the choice of applicators is increasing. It is important to understand the advantages and disadvantages of various applicators, to test them under local conditions and to select the best to do the job at hand. Choices presently include and are reviewed as follows: wipers (Cooper *et al*, 1981); knapsack sprayers (Deutsch, 1984); ultra-low volume applicators (ULV) (Cussans and Taylor, 1978); granular applicators (Siemens, 1979). Education on use and maintenance of equipment is important to avoid situations such as farmers using a knife to open the nozzle "so that the liquid can come out better".

Note: All publications are free and available from I.P.P.C. Oregon State University, Corvallis, or 97331, USA.

Calibration of the above equipment varies in difficulty. Generally, calibration, especially for herbicide application where there is less room for error, is difficult for many small farmers to understand. Accurate measurement of small quantities of pesticides is also difficult. Therefore cooperation between researchers, extensionists and packaging agents is important in order to simplify the process as much as possible. The use of sachets with pre-measured amounts to be used on a tank basis as well as bottle caps calibrated to give the right measure per volume, are useful. Standardization of tank size, or tanks with volume markings, are needed if the pre-measurement system is to work.

Pesticide choice is the second major area of consideration. Who makes the choice? Should there be a maximum toxicology level set legally for small farmers? This action could be an important one in reducing hazard. Guidelines on formulation, keeping in mind safety considerations, should be developed and enforced. For example, granulars are safer than wettable powders which, in turn, are safer than aqueous solutions, emulsions and organic solutions. Also to be considered are, environmental factors and consequences in terms of pest shifts; i.e. broad versus narrow spectrum insecticides.

Labeling and packaging

Standardization of containers for a given pesticide and information put on the container needs to be coordinated by the government with input from industry, research and extension. Special problems arising include: the alternative use of containers to carry food or water; the lack of containers or proper container material; illiteracy problems or confusion over difficult terminology; contradiction in extension recommendations and what is written on the label; poor storage conditions; lack of proper disposal methods. It should also be noted that packaging can cause excessive use. Complete understanding of the farmer's circumstances is paramount.

Distribution, marketing and credit

If pesticide use is recommended and being encouraged, distribution, marketing and credit facilities must be attended to. The risk associated with these often discourages farmers from implementing recommendations. In developing countries, distribution or supply can be a serious problem, usually because of foreign exchange and importation difficulties, as well as poorly organized in-country distribution systems. Some countries, such as Malawi and Zimbabwe are presently well organized in this respect. Credit schemes are useful and aid in providing large amounts of cash at a time when farmers do not have their own. It should be cautioned that credit schemes may encourage over-use of pesticide, if pesticide inputs are a loan prerequisite (Goldman, 1985).

Appropriate, safe use of pesticides by small farmers is often superseded by several assumptions: that services such as credit, banking, advisory, extension staffing levels, supply and information, are available; that the farmer has sufficient management and certain conceptual skills necessary for easy technology transfer; and that farmer's perceptions are the same as the scientist's perceptions concerning pests and their control as well as possessing the necessary motivation and cooperation levels. These assumptions are often wrong, and often make appropriate and successful technology transfer fail. An awareness of the reality of the situation is important as well as an understanding presentation of the seemingly insurmountable problems. The task is before us to make them surmountable and to enable small farmers to use pesticides where their use is feasible and cost-effective.

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The Effect of Pesticide Residues on African Agricultural Exports to Europe

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THE ROLE OF GOVERNMENTS AND INTERNATIONAL ORGANIZATIONS

African agricultural exports to Europe comprise either tropical fruits not grown in Europe (grapefruits, mangoes, bananas, etc.) or vegetables, (green beans from Upper Volta or Kenya) where differences in seasons and climatic conditions give them a natural advantage. All agricultural products are subject to international competition, which means that they have to meet international quality standards, involving careful selection of plants, seeds, and fruit trees and the use of fertilizers, irrigation, and, of course, pesticides.

Under the terms of the Lome convention, which governs the relationship between the members of the European Economic Community (EEC) and its member states and those African countries, which are covered by either the Lome or the EEC-ACP (Africa, Caribbean and Pacific) conventions, the agricultural products of these countries have free access to European markets.

The maximum acceptable level of pesticides in these agricultural products is fixed by the Codex Committee on pesticide residues, which meets every year at The Hague. GIFAP is represented by a large delegation at each of these meetings, and sent 34 delegates in 1984. Residue levels are always the subject of long debates. No decision is taken without passing through all stages of the acceptance procedure, and without obtaining and evaluating all the necessary data. This information is provided primarily by the Joint Meeting on Pesticide Residues (JMPR) which meets every year either in Rome or Geneva, where specialists in toxicology and residues from the pesticide manufacturing companies are brought face to face with independent experts appointed by WHO and FAO. Lastly, the above-mentioned Codex Committee on pesticide residues, taking into consideration the needs and opinions of developing countries, has created a Developing Countries Commission on which the following countries in particular are represented: Gabon, Algeria, Mozambique, the Cameroons, and Egypt.

This means that in principle all the necessary data, based on properly supervized scientific research, already exists and is available to the governments of both the importing and exporting countries. However, as we will see later on, it is perhaps not enough to be informed in order to act, or to be in a position to act.

The agrochemical industry

The agrochemical industry, through GIFAP, contributes directly to the work of the Codex Committee within the framework of the joint WHO-FAO meetings.

Every company manufacturing and exporting pesticides provides the certification authorities with all the necessary data on the acceptable level of residues, the degradation of the pesticides, their metabolites, etc. What is still required is that the company in question have in front of it an authoritative body which is able to avaluate the practical and scientific importance of the question. It is also necessary, of course, that this body exist and be interested in the question.

Any pesticide producing company, after all, is in a position to produce all the necessary information on sound agricultural practices which need to be observed when using its product. By sound agricultural practices we mean: the right stage in the crop growth cycle at which the pesticide should be used, the correct quantities and doses, time intervals between applications, and the interval between the final application and harvesting in order to respect the internationally aceptable levels of residues.

What actually happens

A few years ago, two young American authors with a taste for sensationalism published a book entitled "The circle of poison". The conclusions of this work were immediately taken up by certain of the mass media and ecologist circles right through the world. According to this document, agrochemical companies were then sending products of a toxic nature to the developing countries, and that these products were then returning in the form of the foodstuffs eaten by the inhabitants of the countries these companies were operating in. The circle was then complete.

This is not the place to go into an exhaustive criticism of the conclusions of this document in which the authors, starting out with unchecked and dubious information, imputed to the exporting companies motives which, needless to say, they do not share. However, the question had then been raised at an international level and it is now on the agenda of the "Pesticide Action Network" of the International Organization of Consumers' Unions (IOCU). For my own part, I have difficulty in seeing what further steps agrochemical companies can take. They cannot take the place of government authorities, nor can they undertake to supervise the application of sound agricultural practices, nor can they themselves grant exit visas to agricultural products for export. A survey of pesticide residues in different countries of the world in 1984, published recently by GIFAP is available.

What are the governments of the exporting countries actually doing

In my opinion, we, the participants at this meeting have to ask ourselves the following questions:

- What can exporting companies reasonably be expected to do about the level of residues present in agricultural products, whilst respecting sound agricultural practice?
- What influence does the Codex Committee have on the decisions of the authorities of countries which both import pesticides and export agricultural produce treated with the same pesticides?
- What role do these countries play within the developing countries commission of the Codex Committee?
- What supervision does in fact exist of sound agricultural practices as defined above?
- How is agricultural produce destined for export checked before loading for shipping?

A few examples taken from private conversations indicate clearly that there is still a very great deal to do in order to take action against practices which are not acceptable either to producers, the responsible authorities or consumers.

The question is not only one of the use of unacceptable levels of pesticides but also of the contamination of agricultural products by, for example, the use of packaging material which has been already used for transporting pesticides.

What are pesticide-importing governments doing

I do not have enough information at my fingertips to say that nothing is being done, but I find it difficult to imagine that after taking a sample of, say, a consignment of lettuce from Senegal, of green beans from Kenya, or of fruit shipped either by sea or air, a government authority would take it upon itself to send the consignment back to the country of origin, even if the level of residue was unacceptably high. I find it hard to imagine such a Draconian measure being taken. . . unless of course, the continuing difficulties of European agriculture, which will only be aggravated by the entry of Portugal and Spain, which themselves produce fruit (bananas from the Canary Islands) and vegetables (e.g. green beans and early vegetables), lead the importing countries to impose stricter standards.

What is the EEC doing

To put it very simply: nothing, and for various reasons. Firstly, because it does not have the necessary technical facilities in the form of laboratories. Also it does not have the necessary powers, owing to the lack of delegation of sovereignty by the member states, because it does not have the courage to ask for it, and finally for political reasons which can be summed up under the slogan "North-South dialogue".

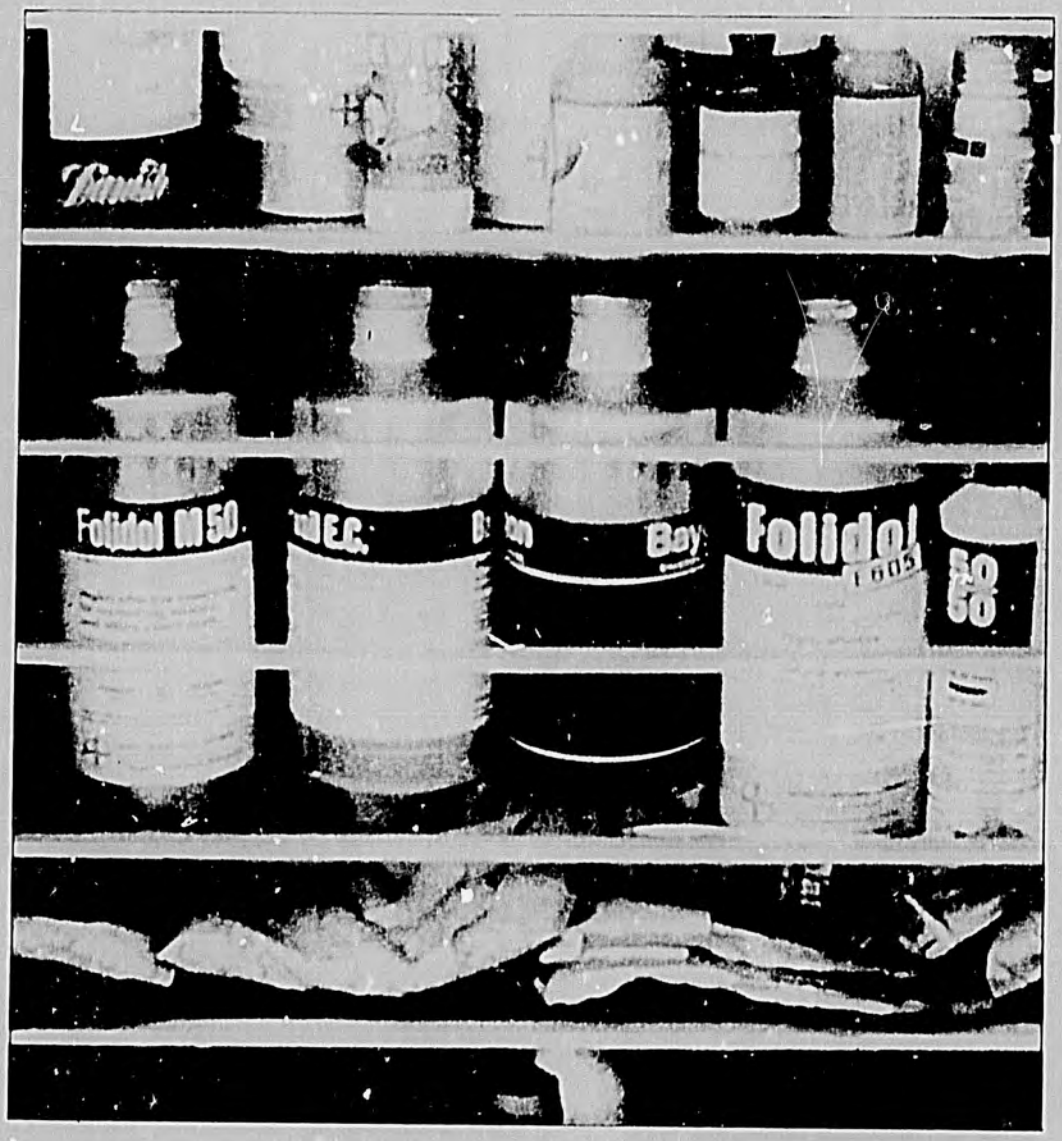
At an EEC meeting in 1981 at Marseilles, France, with members of French-speaking African countries, on the subject of the renewal and application of the Lome Convention, I remember speaking out in public on the question of residues in the presence of Mr. Claude Cheysson, then EEC High Commissioner for developing countries, and prime mover in setting up the Lome Convention. My speech was in vain. There was no reaction, either from the EEC or the agricultural representatives and ambassadors of the African states. Why this lack of reaction? Perhaps because no one was aware of the problem, or perhaps also because people were well aware of the problem, but did not want to consider it because this would have had a negative effect on agricultural trade between the EEC and Africa.

In conclusion if each of us believes that a problem does exist, is it not right that the question be raised at the level of each individual agricultural exporting country? If we break down the problem into its legal, practical, agricultural and regulatory aspects, what practical decisions have to be made, either by each country acting individually, or collectively?

All other considerations apart, all agricultural exporting countries face the risk of seeing the present easy-going approach of the importing countries harden all of a sudden. This is a risk which I do not believe should be taken lightly. If the EEC does not act or does not want to act in the area of controls, it has at its disposal funds which could be used to help find a solution to the problem.

GIFAP is ready to collaborate in any serious initiative which can improve the situation. Perhaps this should be done at a regional level with the help of USAID or other voluntary aid organizations. Perhaps it should be done within the framework of the developing countries commission of the Codex Committee on pesticide residues. It is now the turn of the individual countries to accept their responsibilities.

III.
Industry Point of View on Pesticide Management



COUNTRY PAPERS:

J. Wainaina — Programs in pesticide management — Kenya industry's point of view

A.A. Odipo — Pesticide Chemical Association of Kenya — Does it really help the small farmers?

TOPICAL PAPERS:

E. Nickson — Pesticide formulation plants — Are we protected from another Bhopal disaster?

J. Cosse — Industry initiative worldwide to promote the safe and effective use of agrochemicals

Programs in Pesticide Management (Kenya Industry's Point of View)

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ABSTRACT

Pesticides are potentially dangerous. The nature and magnitude of the problems which pesticides present now and in the future as a result of their (pesticides) manufacture and use are immense. The unfavorable status is worsened by the fact that neither governments, nor industry, nor individuals, have adequately played their roles in this regard. Even where efforts are expended by one party, one or both of the other parties deliberately or inadvertently act in ways that hinder or retrogress the good intentions of the active party. So that eventually there is total lack of unison and common purpose at the expense of all.

Kenya is a good example of where government and industry have a good record of working together. However, a lot has still to be done in order for this country to fully benefit from these contributions. This paper outlines the activities and states the views of the Kenyan pesticide industry through the Pesticide Chemicals Association (PCA). Problems encountered by the PCA in its endeavours to eliminate, or at least reduce hazards associated with the use of pesticides are also highlighted.

The author assumes that use of pesticides is acceptable and that the real issue is the elimination of hazards thereto. There is, therefore, no attempt to defend the use of pesticides.

LIMITATIONS

This paper borrows heavily from an earlier paper by the author entitled "Hazards from Agricultural Inputs - Who Cares?", presented in partial fulfilment of an MBA degree under the supervision of Dr. Chege Waruingi at the United States International University in May 1983.

BACKGROUND

That the pesticide industry in Kenya led the government in attempts to curb the uncontrolled distribution of pesticides is widely accepted. The Pesticide Chemicals Association of East Africa was registered in late 1958. And although initially it was primarily a trade association, it has, during the last 10 years, evolved into a genuine regulatory body with a code of ethics which requires members to exercise self-discipline. This code of ethics was in force long before the government's Pest Control Products Act was enacted in 1982. In fact, of all the parties which agitated for the introduction of the Act, PCA was prominently in the forefront. This genuine concern was rewarded by the authorities by making the association a permanent member of the Pest Control Products Board (PCPB) which was created by the Act.

The industry's view is that when used carefully, pesticides should work for us and not against us. The industry, in Kenya, further believes that most problems which make pesticides appear to be working against us can be either avoided, eliminated or greatly reduced. This belief is based on the observation that these problems are caused primarily by carelessness and ignorance on the part of users, omissions, misrepresentations, misinformation and irresponsible actions on the part of the industry, and lack of concern, slow action or inaction and individualistic approach on the part of the government. All these shortcomings can be satisfactorily corrected through genuine concern for the real problems, by all the parties involved.

In furtherance of this belief, the PCA has undertaken various activities aimed at making pesticides not only less hazardous to users but also cheap.

LABELING

Perhaps the single major reason for misuse and mishandling of pesticides, and the resultant hazards, is ignorance on the part of the user. Sometimes information is not available, or is incomplete; some other times the user is misinformed through deliberate omissions; and some other times the user is either careless and does not use the available information or is unable because of the literacy level, to use it. To minimize these problems, the association expects members to meet the following minimum label requirements:

- Be in a language(s) most understood by users, which in our situation is English and Swahili.
- Be legible, avoiding small prints as in insurance.
- Be clear, to the point, and with no ambiguities.
- Indicate clearly the recommended usage, rates and restrictions.
- Carry a statement on precautions users must take while using.
- Indicate clearly the ingredients.
- Carry storage instructions and where applicable date of formulation and shelf life.
- Give disposal instructions and instructions on how to deal with spillages.
- Carry first-aid instructions and a note to a medical practitioner.
- Conform to existing laws on labeling.

Although the requirements have been agreed upon no compliance date was set, and given the quantity of old labels already in stock, some products from bona fide companies who are members of the association still have inadequate labels. Moreover even some products from members who have fully complied may still be found with old labels because of low stock turnover in some outlets.

The label requirement has been followed by constant reminders through posters, leaflets and adverts in the mass media exalting users to read labels carefully before using a pesticide. The association spends approximately US$ 6250 on these activities annually.

DISTRIBUTION AND STORAGE

The PCA recognizes distribution and storage as the other major areas of mishandling and misuse and thus sources of hazards. The industry is concerned that the distribution channel is littered with thousands of tiny shopkeepers (estimated at 20,000) who stock pesticides but who know nothing about them. In most cases, these are sold side by side with foodstuffs in complete ignorance or disregard of potential hazards. Our liberal "free enterprise" system makes it possible and perhaps inevitable for shopkeepers to mix product lines in spite of possible dangers. Demand for pesticides in a certain area may only be enough to support say three shops. However, since there are no restrictions, there could be as many as 10 shops in a centre, which must therefore carry additional lines (foodstuffs not excluded) in order to survive. Moreover, such shops have no adequate storage facilities. The industry's viewpoint is that unless and until pesticides are sold in specialized and controlled premises, hazards through distribution and storage will persist and deteriorate. The industry has no means of controlling this and its contribution is limited to urging the PCPB to institute necessary measures such as, to:

- License only a certain number of premises in each centre so as to make business paying and thus discourage discreet or open carrying of other product lines;
- License only premises with adequate and proper storage facilities;
- License only those who are themselves or their employees qualified or are somehow competent to handle pesticides. In this respect, the board should have a basis for assessing the competence of those with no formal qualification.

And as a complement to these requirements on licensing, legal penalties upon owners and their employees (or some other suitable deterrent measures) should be considered for:

- Overstocking and poor or fraudulent records.
- Careless or deliberate wrong advice to users resulting into hazards.
- Careless disposal of pesticides without consulting relevant authorities.
- Careless storage and dirty, unkempt premises.

FORMULATION AND REPACKING (LOCAL)

Although the most appreciated pesticide hazards are associated with usage, formulation and repacking activities expose workers to hazards. Moreover, these activities may exacerbate end-user hazards if they result in inferior products and sub-standard packaging material.

Nevertheless, economic factors cannot be ignored when deciding on local formulation. On the national level, bulk imports cost approximately 30% less than imports in small, ready-to-use packs*. This obviously means that much less foreign exchange requirements for this import. And when you consider that the annual C&F value for Kenya pesticides bill is approximately K.Shs. 350 million, this is not a meagre saving. In addition, freight is anything between 25 to 30% of the C&F value for most pesticides**. And given that some finished products contain as low as 2% active ingredient, this means that the transportation cost of readily available inerts can be as much as 29% of the C&F value[1]

Little wonder then the PCA encourages local formulation and repackaging. There are at present several formulating and a few more repackaging facilities in Kenya. Some of these have been in operation for over a decade with no known major hazard. Before the 1982 Pest Control Products Act, these premises were under the Factories Act and were thus inspected and licensed. But they are now under the more stringent supervision of the PCPB which we welcome. Our only concern is that the vigorous supervision we have pushed for will not be implemented fully soon enough due to lack of personnel.

As a small disgression which is perhaps excusable, we may note here that a confusion in the Customs Department inadvertently penalizes local formulation and repackaging. The PCA, with full support and assistance of the PCPB has launched a complaint with the Treasury.

SAFETY

All the foregoing has touched on the industry's concern on safety. Indeed, over 70% of the association's activities and expenditure are on safety-enhancing programs. The industry's view is that users easily forget; therefore, they should be constantly reminded about dangers inherent if pesticides are not handled carefully and used only as directed. To this end, PCA carries constant reminders in the mass media and distributes posters and leaflets with the assistance of the Ministry of Agriculture.

The industry works closely with relevant govern-

Footnote *1 litre of pyrethroids in an aluminium container for example, cost approximately 28% more than the same litre. In a 200 litre drum

**Of the C&F value of $1.65 per kg of Furadan (a reg. trademark of FMC Corp.) 5% granules, for example, $0.45 or approximatel, 27% is freight cost. This means that it cost approximately 26% of C&F value to transport inert materials to the country.

***Kenya shilling — approximately K.Shs. 16 = 1$US

ment departments and institutions and cooperates in all ways towards the safety goal.

PROBLEMS

It is worth noting that the PCA remains a private institution with no legal policing or enforcing powers. The worst punishment the association can mete out to non-conforming members is expulsion and subsequent loss of use of the PCA logo. However, this is hardly a sufficient deterrent because the expelled company can still obtain import licences from the authorities and carry on trading without hindrance. The association believes that the PCPB should eventually consider confining pesticide importation and trading to PCA members. This will greatly enhance their policing and enforcement as the board will, for most practical purposes, be dealing with one body as compared to scores of traders scattered all over the country.

A major source of dangerous pesticides in Kenya is smuggling. It is well known that Tanzanian farmers who get subsidized chemicals through bilateral and multilateral aid find a lucrative black market in Kenya for these inputs. This encourages adulteration and misrepresentation of products. The *Daily Nation* of 25 March 1984 reported an incident where 44 head of cattle died after being sprayed with a chemical which the owner admitted to have obtained from a neighboring country.

But the PCA can do nothing about this dangerous practice, mainly perpetrated by non-members, except to urge authorities to curb it. Yet whenever hazards to man, crop, animal and the environment occur as a result of the misrepresented or adulterated smuggled chemicals, the industry takes the blame. The PCA cannot forecast genuine control and regulation of pesticides while the smuggling issue is left unattended.

The association is also perturbed that almost three years after the Act, the PCPB has yet to take in enough personnel to enable it to embark on its noble duties. We sincerely hope that somebody is seriously looking into this.

CONCLUSION

In Kenya the industry works closely with the government institutions charged with regulating use and distribution of pesticide. The industry has made invaluable contribution towards the controlled use of pesticides, firstly, through voluntary self-control and discipline and, secondly, through lobbying for relevant legislation, and, finally, through continued cooperation with the regulating institution. The industry's viewpoint is that this sort of relationship is ideal for successful reduction or elimination of hazards associated with the use of pesticides, and that it should be encouraged and improved upon.

The industry in Kenya takes an active part in pesticide use. It avoids the two extreme stands represented by Schapiro and Weir (1981); on the one hand, and some industry diehards who cry "witchhunt" whenever the issue is raised. We believe that as long as pesticides remain the most viable means of controlling pests, everyone must sincerely and positively contribute towards solving the real problem in pesticides use — hazards. For they do exist. This is the active role which we share with Keith Burrow (1981).

REFERENCE

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Schapiro and Weir, D. 1981. *Circle of Poison.* San Francisco: Institute for Food and Development Policy.

DISCUSSIONS

Q. (Alford). Could you clarify your inference that sellers and retailers should be held legally responsible for proper representation of label distribution?

A. (Wainaina). I did not say sellers and retailers should be held legally responsible, but I must re-emphasize that, in Kenya, we have thousands of retailers who do not know the ABC of the products they sell. Retailers are often over-enthusiastic in their selling and offer products saying that they "control everything". Industry wants to see this tendency eliminated. This is a real problem.

Q. (Tukahirwa). Are all companies engaged in repackaging and formulation of pesticides in Kenya members of the PCA?, and, secondly: You said that PCA believes that self-discipline of the industry is the only way to solve pesticide safety problems. Surely some companies have amenities which require independent inspection?

A. (Wainaina). What I said was that self-discipline of the industry is not the only way to solve problems, but it must complement other efforts being made. Governments would have a very difficult task in inspecting and enforcing precautions if the industry is not cooperative. Self-imposed discipline will greatly help government efforts. In answer to the first question: Companies join PCA on a voluntary basis. At present there are 44 members who are in regular pesticide business. There are no members who are involved in off-licence.

D.M. Roceo endorsed J. Wainaina's last remark by saying that all PCA members have a registered number and put the PCA logo on their labeling. Consumers now consider this logo a mark of quality.

Pesticide Chemicals Association of Kenya — Doest it Really Help the Small Farmer?

by
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INTRODUCTION

Kenya, with an area of 583,000 km² and a population nearing 20 million people, has a high geographical diversity; the lowlands, highlands and the Rift Valley. Climate and vegetation show great variation from region to region. For agricultural purposes, the country can be divided into five distinct farming areas:

- High potential land in the highlands that require little or no pesticides use.
- Average potential land in Western and Nyanza provinces.
- Moderate land in Central and parts of Eastern provinces, requiring intensive use of pesticides.
- Semi-arid land in parts of North Eastern, Eastern and the Rift Valley provinces where pesticides are used on a very small scale unless irrigation is being practised.
- Arid land. No farming is practised here except ranging. Only acaricides are used here.

The "small-scale farmer" in the Kenyan context can be categorized as follows. During and immediately after the colonial era, a small-scale farmer was defined as one owning 0.25 to 10 ha. in the high potential, and moderately potential areas of the country. This was true until the early 70s when these large farms were divided into smaller ones.

Today, this definition is no longer valid. There is an "intensive small-scale farmer" who owns between 0.25 and 2.5 ha in any of the three potential areas of the country. He is profit-conscious and uses a lot of chemicals for optimum yield. In most cases he has little or no technical knowhow and no education about the risks involved in the use of pesticides.

There is a resource-poor farmer, who owns a lot land, for example in the semi-arid and arid areas. Although he owns plenty of land, he can only utilize a small portion of that land because there is very little rain in the area and he cannot afford the irrigation system and the chemicals. He is often termed as a subsistence farmer because more than ¼ of what he produces is consumed by the family.

In this report, I will deal with the "intensive small-scale farmer" and his relationship with the Pesticide Chemicals Association of Kenya. As mentioned above, this farmer is a businessman and his concern is profit. His farm can be utilized in different ways at any one given time. He can be a floriculturist, a horticulturist and rear animals all at once.

As a floriculturist, he grows flowers for sale and uses insecticides, fungicides, fumigants and growth regulators for maximum production.

As a horticulturist he grows cereals, pulses and vegetables. Some of these are grown for food but the majority are for sale. For this purpose, he requires insecticides against all kinds of crop borers, fumigants against storage pests and fungicides against noxious weeds.

Livestock such as cattle, pigs and poultry are reared both for food and sale. In this area the farmer relies on pesticides such as acaricides.

Coffee and tea are also often grown on such farms requiring the use of herbicides (to a small extent) such as Copper Oxychloride, Captafol, Delan, Sicarol, Dieldrin, Ferritrothion, Paraquat and Glyphosphate.

The problems associated with this use of pesticides on intensive small-scale farms include the effects on the agroecosystem, possible pesticide poisoning for the workers, lack of technical knowhow and pressure from the Pesticide Chemicals Association to buy more and more chemicals.

In Kenya the following problems have been experienced:

- The pesticides are expensive and the improper application and wrong formulation make them even more costly.
- Waste occurs through wrong application and poor timing, wrong formulation and maldistribution result in failure to control pests.
- Careless use results in human exposure, destruction on injury to beneficial and economically important organisms, environmental contamination, unwanted residues and due to improper disposal and contributes to the development of resistance.
- Ignorance about the chemicals leads to dangerous practices such as mixing different chemicals in the hope of obtaining better results; improper storage of surplus chemicals such as in bedrooms, grain stores, Coca Cola bottles or any other household utensils.
- Spraying equipment, mixing buckets and tins are washed in streams where water for household use and livestock is drawn. Chemical containers are used to keep foodstuffs as well as fetch and store drinking and cooking water.
- Farmers are often not advised on the importance of protective clothing.

When there are any clothes, they are too uncomfortable because they have been designed for the temperate weather.

RELATIONSHIP WITH THE PESTICIDE CHEMICALS ASSOCIATION OF KENYA

There are three main problems that face the farmers in their relation with the Pesticide Chemicals Association of Kenya and any other chemical companies in Kenya and elsewhere in the Third World.

LABELING

All pesticide labels must contain "signal words" in bold print to attract the attention of the user: DANGER POISON WARNING CAUTION. These are significant words since they represent a category of toxicity of the chemicals, and thus give an indication of their potential hazards. Pesticides should then be categorized according to their level of toxicity according to the following EPA standards:

Category 1. The signal words, DANGER, POISON, and the skull and crossbones symbol are required on the labels of all highly toxic compounds, falling within the acute oral LD50 range of 0-50 mg/kg.

Category 2. The word "WARNING" is required on the labels of all moderately toxic compounds, within the acute oral LD50 range of 50-500 mg/kg.

Category 3. The word "CAUTION" is required on labels for slightly toxic pesticides that fall within the LD50 range of 500-5000 mg/kg.

Category 4. The word "CAUTION" is required on labels for compounds having acute LD50s greater than 5,000 mg/kg. All labels must bear the statement "Keep out of reach of children."

In Kenya, it is difficult to tell whether the manufacturing companies refuse purposely to attach proper labels while exporting the chemicals or the importing chemical companies retain these labels for the fear of losing market! Whatever the case, the farmer is sold a chemical without any labels or instructions on how to mix and apply it. He depends on the salesman who in turn has had minimal training on the chemistry of pesticides.

ADVERTISING

Advertising campaigns should inform and educate users and the general public in addition to promoting the product. Proper use, limits and hazards should be emphasized together with benefits in order to improve general agricultural practices and protect human health and the environment. Local cultural sensitivities and concepts should be taken into account. Manufacturers should use language or symbols that are easily understood by users. Health risks should be stated explicitly, using language or symbols readily understood by all. However, in the Third World, and Kenya is no exception, advertising is all misleading with regard to health and environmental hazards of the products. It dwells only on the advantages in complete disregard of the risks. For example, it is often not stated whether a product has a single or very limited application only. No statement is ever issued on the need for proper handling of pesticides and disposal of containers.

RECOMMENDATIONS

While what has been said so far tells the problems facing the farmer in the use of pesticides, it is important to mention here that it will continue unless the people handling these chemicals are instructed on their toxic effects. In order to take the precautions necessary to avoid hazards, these individuals should have an understanding of the nature of the chemical with which they are dealing, how they might get exposed and the steps to take to avoid this exposure. They should be aware of the hazards of spills of the chemical, exposure to the fumes and the necessity of washing off of any contamination of the skin immediately.

Thus a worker, farmer or an agriculture extension worker should know about the basic facts about the chemicals; toxicology and safe handling procedures; protective clothing; hygiene and first-aid; accident response; and last but not least the proper use of chemicals and how best this can be achieved.

This can be done through training sessions prior to employment, booklets and instruction kits, film strips, seminars and workshops, special lectures and demonstration.

The agricultural extension worker should have at least six months to one-year special training on the ecological studies of pests in order to determine the ecological basis of the pest problems by evaluating what factors in the agroecosystem can be manipulated to make the overall environment as unfavourable as possible for weeds, insects, and plant pathogens while producing an optimal crop yield. He in turn will train the farmer to determine if and when pesticide treatment is necessary.

Training should not only be the responsibility of governments involved but of the chemical industry and other industries involved in agriculture. It would be most desirable if the government and the Pesticide Chemicals Association of Kenya could all join forces in a common program to advise those who handle and use pesticides on how to avoid their adverse effects.

DISCUSSION

Q. (D. Mukunya): Wondered what Mrs. Odipo's conclusion was. Is the PCA helping the small farmer or not? The pesticide industry in Kenya is worth more than $12 million, 60% for coffee, 20% for cotton, the rest being horticulture and food crops. Only 5% is for the small farmer. The question is, who is the target — probably not the small farmer, but possibly more the town population using the end products.

A. (A. Odipo): The small-holder buys the product on his own. The PCA does not advise him. He rejects the extension worker. If one product fails he tries another. The PCA does not help the small farmer.

Q. (Auma-Osolo): Research in the United States is funded by the industry. Why not here? We are here to help and will do the work objectively and in a harmonious fashion.

Pesticide Formulation Plants — Are we Protected from another Bhopal Disaster?

by
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A PESTICIDE MANUFACTURING PLANT

A pesticide manufacturing plant is one which utilizes two or more basic feedstock chemicals during a manufacturing process. It must also employ heat-catalyst pressure-acid coupling-optical chemistry to change the nature or form of the feedstock items into a product which (in the main) is chemically and physically different from the original ingredients.

Typically, a technical pesticide contains 90% of the active ingredient. In some cases (e.g., new synthetic pyrethroids) it is more economic to manufacture 50% — 55% active content.

Technical ingredients can be liquids, fine crystals, powdered flakes, solid cake or lumps. It is the technical product or active ingredient which possesses the biological properties. The active ingredient as produced in a manufacturing plant is, in the majority of cases, not suitable for use (as is) by the end user. It is insoluble in water and certain solvents would not remain in suspension, would be difficult to apply or may be phytotoxic to plants and animals and so would be hazardous to handle. To transform the active agro-chemical into a form which is safe and usable, the chemical is "formulated".

PESTICIDE FORMULATION PLANT

Pesticide formulation plants transform the active ingredients into a form which can be applied by practical methods to permit its effective, safe and economical use.

Formulation is the physical mixing or blending of one (or more) biologically active chemicals with specific inert ingredients that convert it into a form that is convenient to use, stabilizes the active ingredient and makes it less hazardous to the end user.

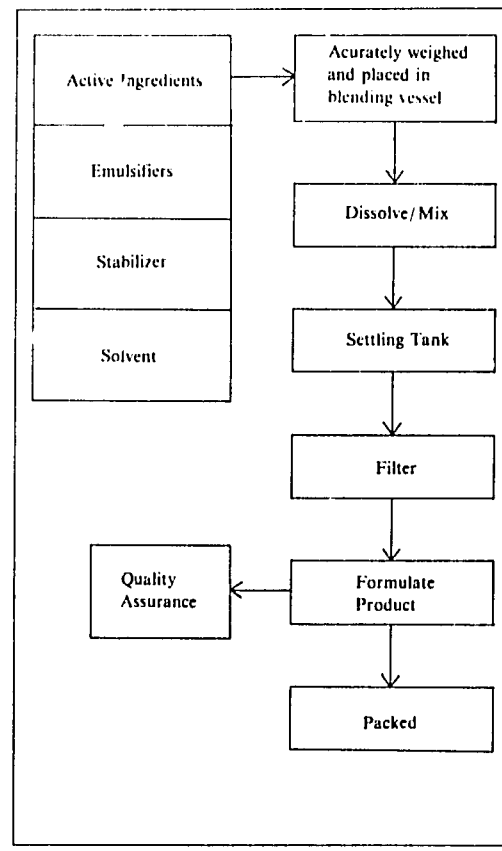
Formulation can enhance the biological activity of the product, for example, by particle size — retention.

A pesticide formulation is in two general types based on physical form. Liquids: Oil concentrates (ULV), emulsifiable concentrates, aqueous concentrates, suspension concentrates, invert emulsions, dry formulations, water dispersible powders, dusts, flowable formulations, granules/pellets.

The commonest pesticide formulations used and formulated in the ESA region are emulsifiable concentrates. An emulsifiable concentrate consists of the toxicant or active ingredients, or emulsifiers — usually a "balanced pair", or the solvent(s).

The solubility characteristic of the active ingredient determines the solvent type. The physical nature of the combined toxicant and solvent determines the type of "emulsifier balance" to be used. Once the formula has been determined the emulsifiable concentrate is prepared as shown in figure 1.

FIGURE 1
PREPARATION STAGES OF AN EMULSIFIABLE CONCENTRATE



HAZARDS ASSOCIATED WITH FORMULATION

Potential hazards that occur in the formulation plant are usually as a result of intoxication by pesticide absorption through skin; the inhalation of fumes or dust and/or the actual ingestion of pesticide. It is also a well known fact that fire is frequently a cause of hazards. Organic solvents are flammable and finely powdered organic pesticides can explode if ignited. Environmental contamination through accidental discharge of toxic chemicals into environment and poor waste management is another potential hazard.

There are several ways in which these hazards can be reduced or eliminated. Some of the ways of reducing or eliminating hazards are discussed below.

Education

Only well-informed personnel will readily take the proper precautions to protect themselves, their co-workers and the environment. Therefore, all staff should be well trained and supervised on protection measures. An important aspect in the education of workers is the administration of a regular training program.

The areas that should be covered under such a training program should include potential hazards of chemicals handled, correct and safe use of equipment, hygiene, safety instructions and procedures on spillage, fire, injury and contamination.

Measures against intoxication

Precaution against absorption of pesticides through the skin should include the wearing of appropriate protective clothing such as cotton overalls with long sleeves, rubber boots, protective aprons (neoprene rubber, protective gloves), neoprene/nitrile and face shields.

Protection against inhalation of pesticide fumes or dust should include the wearing of protective clothing (as above), respiratory/dust masks with filter as well as natural and artificial air ventilation.

Actual ingestion is the least common cause of accidental poisoning in formulation plants. It happens mainly when staff take food/drink into working area or smoke when hands are contaminated. This can be avoided by appropriate worker education.

Medical supervision

All employees and contract staff should have pre-employment medical examinations followed by yearly examination. These should include cholinesterase determinations for possible OP contamination, pre-exposure baseline cholinesterase levels determination as well as regular pre-post blending/packaging checks.

Fire prevention

Liquid pesticides contain organic solvents which are flammable; therefore all electrical equipment and switches should be flame/explosion proof. In addition, all vehicles entering blending area should have flame/spark proof arrestors. Furthermore, filling hoppers/filling lines should have vapour extraction hoods/exhaust fans fitted. All vents on blending vessels/storage tanks have fire arrestors.

Installation fire plan with well practiced emergency procedures such as monthly fire drill; supervision by a fire prevention advisor; twice yearly "live fire" drill; liaison with municipal fire authorities; serviced monthly.

Accidental discharge

To control accidental discharge that contribute to environmental pollution, it would be necessary to establish interceptor pits, bund wall around blending/settling vessels, and around pesticide store to contain spillage/fire water, and to monitor air filters/cleaners. Decontamination and incineration are additional appropriate waste management techniques.

DISCUSSION

Q. (Latigo). Is it necessary to measure aerial contamination in the vicinity of the plant, in order to reduce environmental contamination?

A. (Nickson). It is a normal procedure to measure contamination in the vicinity of the blending plant. One could consider measuring contaminants in exhaust fumes. It would be difficult to establish the need, especially when there is a constant coastal breeze, ventilating the blending area, which disperses the fumes. In case of large quantities being handled, it is a useful suggestion, but today, we have not taken this precaution.

A. (Gaudet). Following the paper given by the PCA Chairman it is evident that the PCA is in an excellent position to provide background information needed especially with regard to amounts of pesticides actually being used by small-holders. This is offered as a suggestion. Pesticides have been noticed in supermarkets with no labels. PCA is in an ideal position to provide knowledge on status of pesticides and the industry in Kenya. Where is the Shell formulation plant located?

A. (Nickson). The plant is in the Port area of Mombasa and not in the vicinity of human habitation.

Q. (Mukunya). Congratulations to the three speakers. Industry sounds wonderful and, in Kenya there would not be a Bhopal when all the precautions and goodwill were taken into account. This concern was for the potential mini Bhopals in local formulation facilities, in godowns and in village situations. Industry cannot be blamed, but a real problem is how to ensure that protective clothing is worn. There is a real reluctance by workers to wear protective clothing. Efforts have been made by government and industry and neither is at fault but more comfortable clothing should be developed.

A. (Nickson). This is a valid point. Shell only have people wearing uncomfortable protective clothing when it is necessary (specifically cotton overalls, boots and gloves). Masks were worn for specific tasks. During the course of normal warehouse hygiene, complete protective clothing would be required. But in the case of stores with broken packets and spillages, it would be necessary. In the field, it is a difficult problem. The company advises appropriate measures. New products being developed are tending to be less toxic (e.g. synthetic pyrethroids) and this partly addresses the problem, otherwise there is really no solution.

A. (Wainaina). Industry can advise and indeed should insist on better measures. Supervision is often lacking and employees and managers should be more strict.

Q. (Kiss). How are other waste materials sent back to Holland for disposal, and does this infringe on any Dutch law?

A. (Nickson). This is an infrequent occurrence; two drums once or twice a year, because organochlorines are not used much nowadays. It is not infringing on any Dutch law. In the Shell facility in Holland, there is suitable incineration equipment. There is a local plant audit and an audit is carried out by the company's health and safety unit.

C. (Kibata). Suggested that a defeatist attitude had been expressed on the question of protective clothing. GIFAP should be requested to come up with a solution. There is a lot of exposure at distribution points and in particular with handling of pesticides by cooperative societies. These outlets should be considered and evaluated in relation to appropriate measures. Waste management is a big issue. There are a lot of old stocks. Are we doing the right thing?

J. Davies, Miami, USA, commented on protective clothing. Is there much merit in individual research on exposure assessment and in exposure minimization. Metabolites of pesticides are easily detectable in urine. There are devices which show how much penetrates clothing and adheres to workers. 100 per cent cotton has been found the best material for overalls and exposure of workers is minimized when they are wearing cotton coveralls. Effect on laundry is an important area to research with regard to residual efficacy of pesticides. The use of a Monday suit and a Thursday suit is good practice. Things are so different in Africa that it is essential for each country to do its own exposure assessments.

A. (E. Nickson.) In reply to G. Kibata on waste management. Industry must work side by side with government on this issue on such subjects as choice of dumping sites. In Sudan there have been long discussions without solutions. Now Shell Sudan have a small incinerator. Waste disposal is a joint effort.

C (L. Malaret). E.L.C. Nairobi: Commented that he was encouraged to see that industry is ready to work with government and environmentalists. These issues concern people. The solution is for items to be tackled by those "who can do it best". Industry is in a strong position to provide initiative. Labeling is not sufficient. African farmers often do not have enough money for protective clothes. He suggested gloves attached on package and disposal at farm level through returnable packages with deposits on bottle, and light masks. This could take the form of joint projects but industry must deal with it. Local organizations will help.

(J. Wainaina). With regard to suitable premises, we do not have a defeatist attitude. We do insist that premises must be suitable and proper. That is the best we can do. A law to back it up will further this effort.

C. (D. Rocco.) There is a lot of toxic waste in Kenya. A lot of it belongs to the government. It is important to get together on disposal.

(R. Gatumbi). Ministry of Agriculture, Kenya. Poor farmers do not have and cannot afford suitable measuring devices. A particular problem is weighing small quantities of powder formulations. Another problem is competition between company representatives where new products are sold to farmers when other products are in farmers' stocks.

A. (J. Wainaina). This point is taken.

C. (Osman Gallal). Gezira Board, Sudan. Government extenionists should have a greater role in advising farmers than company representatives. In Sudan a different situation exists where government procures and applies products on behalf of scheme tenants.

C. (H. Alford) University of California, USA. In U.S.A., farmers cannot comply with labeling requirements for protective clothing due to excessive temperatures. In California an applicator is required by law to wear protective clothing.

Industry Initiative Worldwide to Promote the Safe and Effective Use of Agrochemicals

by
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The agrochemical industry is very often presented by the media as deliberately pursuing profit-making objectives without taking account of its responsibilities towards the world which surrounds it. The criticisms are too numerous for us to reply to, but one of the most frequent criticisms is industry's failure to recognize safety rules for the manufacture, distribution and use of its products which are, by nature, toxic.

Industry's responsible attitude towards safety will be shown here. However, this responsible attitude must be, and is, shared with governments, in particular, with registration authorities, distributors and users. Industry cannot be held responsible for all safety problems which arise when pesticides are used. This responsibility is shared with the other parties concerned. It is all the more obvious that this responsibility must be shared if we consider that governments must exercise their complete sovereign rights, and that these sovereign rights lead to obligations toward their countries' citizens and environment. These countries, which obtained their independence over a generation ago in Africa and Asia and many generations ago in Latin America, do have the necessary intellectual and scientific elite and if these obligations are not fulfilled, it is often due to the absence of an awareness of these obligations. Although the elite exist there is an absence of technical and financial resources. However, cooperative aid exists and could be channeled towards the fulfillment of these obligations regarding the use of pesticides in so far as recipient governments are politically willing.

The presence here of delegates from 18 African countries meeting under the auspices of USAID proves that political willingness exists. Once again, putting the whole responsibility on the shoulders of the agrochemical industry, which is generally of Western origin, would be to show a kind of neo-colonialism or "big-brother" attitude. My intention therefore is to define industry's responsible attitude regarding the safe use of pesticides.

ABOUT GIFAP

The Groupement International des Associations Nationales de Fabricants de Produits Agrochimiques, GIFAP, is the international trade association of the manufacturers of agrochemicals. The federation, originally European, was founded in 1960.

GIFAP now represents 30 national associations, comprising more than 950 companies. These produce over 90% of the agrochemicals throughout the world.

Member national associations of GIFAP have common objectives — to promote crop protection by appropriate use of agrochemicals world-wide and to ensure that the properties and application of these products are in conformity with the needs of agriculture and society, i.e. optimal food and fibre production with minimal hazards for man, animal and environment.

To achieve this, GIFAP's aims are:

- To promote the safe and sensible manufacture, handling, packing and transport of agrochemicals by setting, and recommending high standards, in conformity with internationally acceptable rules.
- To promote the safe and sensible application of agrochemicals, in conformity with national and international standards and regulations for the protection of the user, the environment and the consumer.
- To promote the harmonization of national and international legislation and regulations concerning control, testing and approval of agrochemicals.
- To provide a forum for discussions, expert advice and information on international scientific, technical and practical problems such as toxicology, residues, environmental issues, regulatory affairs, information and education, which affect industry, agriculture and society as a whole: and to seek to solve these problems.
- To help the public to understand the purposes and the nature of agrochemicals and the benefits they bring to food production, health, the economy and related areas.
- To act on behalf of member associations, to take a position on all technical and scientific domains which interest, directly or indirectly, industry with regard to international and inter-state bodies, including FAO, WHO, UNEP, UNIDO, EEC and many others.

This action will particularly concern matters of regulation and legislation, toxicology, residues, ecology and transport.

In order to implement these objectives, GIFAP's Executive Committee, based on the well-founded opinion of its members (and you have seen the growing importance of developing countries), decided in 1981 to set up regional working groups. We began with the Latin America Working Group and then the Asia Working Group. The Africa Working Group was created in 1984. We will come back to the activities of this group later on.

WHAT DOES GIFAP DO REGARDING SAFETY

We would like to recall that agrochemicals, which are by nature toxic, do serve a purpose and that this purpose is to contribute to improvements in crop protection (increases in agricultural production estimated at between 30% and 50% according to the region, agricultural practices and varieties) and the protection of populations from tropical disease through vector control. In themselves, therefore, pesticides contribute to the safety of populations through the provision of food and protection against disease.

Without the efforts in research and development made by the major international companies, what would food safety be? Let us recall that each new molecule put on the market costs between US$25 and 30 million in research and development. Along with selected seeds, irrigation and fertilizers, pesticides contribute to the fight against hunger in the world.

GIFAP's contribution to safety is achieved through its contribution to safe use.

GIFAP's action takes three forms:

- In liaison with the competent international organizations: FAO, WHO and UNEP.
- In liaison with international programs and governments.
- Direct action in collaboration with member associations.

GIFAP's international partners are principally the FAO, WHO and UNEP but the group also works with other international or inter-governmental organizations such as the EEC, OECD and UNIDO.

With the FAO and WHO, GIFAP contributes to the eleboration of specifications for products which are marketed internationally. The establishment of international specifications replies to a frequently expressed need to have a uniform means of measuring quality which is accepted world-wide. It is regrettable that such specifications are not always used in the tenders made by some African countries. This opens the way for some rather unscrupulous "repackagers" and certain brokers who should be kept away from the market. It is in the absence of precise specifications and controls that products are imported without certificates and with inadmissible levels of impurities. By contributing to the establishment and respect of international specifications, GIFAP thus contributes to safety.

During 1985, GIFAP will be publishing a booklet on quality control covering all aspects of quality levels linked with safety, the organization of control laboratories, methods of analysis, sampling, storage conditions and others. With the WHO, GIFAP and interested companies contribute to the updating of a classification system according to a hazard assessment of different active ingredients. If certain reserves are expressed by GIFAP on the extrapolation of this acute toxicity data, GIFAP nevertheless closely follows WHO's activities in the domain since the objective of this classification of active ingredients is to define the wording on labels.

With the WHO, GIFAP collaborates in the definition of conditions for the safe use of pesticides. GIFAP regrets, however, that sometimes the WHO does not attach enough importance to the question, for example, by not including a chapter on the safe use of pesticides in its manuals destined for primary health agents. Due to the extent of its collaboration with WHO and its international representation, GIFAP has just been accorded the official status as a non-governmental organization.

With the WHO and FAO, GIFAP collaborates in the field of residues in the work of the Joint WHO/FAO Meeting on Pesticides Residues (JMPR) and to the work of the Codex Committee on Pesticide Residues. With the FAO, GIFAP collaborates in the international harmonization of registration requirements.

Contrary to what may be thought by some people, the agrochemical industry favours government controls on pesticides used on their territory. However, these controls must be based on internationally accepted scientific criteria.

This is an activity which the FAO has carried out for many years and which reached practical conclusions at the conferences organized by the FAO in Rome, in 1977 and 1982. Even if GIFAP has not always agreed with the FAO guidelines as a whole, the fac that these guidelines have been adopted by the international community has led to the moral obligation for GIFAP to contribute to their implementation. Consequently, wherever questions of registration arise in the world, GIFAP recommends the adoption of the FAO guidelines.

It is perhaps in Africa that there is the greatest need for progress but each country must be dealt with separately, even if it is a question of respecting common guidelines applicable to everyone.

Safety cannot be ensured if a government does not assume its sovereign responsibilities by fixing the limits of use for a given product. It is not the manufacturer's responsibility to decide unilaterally on the use of its product in a given country but rather to respect certain voluntary rules which will be discussed further on. GIFAP's final objective is to see each government carry out a risk/benefit analysis for each product and to make a decision. By encouraging government control of pesticides, GIFAP therefore contributes to safe use, it being understood, of course, as laid out in the FAO guidelines, that all necessary information must be brought to the attention of the government concerned.

With UNEP, GIFAP collaborates in the field of environmental protection which is an integral part of every safety program. This collaboration is ensured within the International Program on Chemical Safety, a UNEP/ILO/WHO-sponsored body, by a liaison ensured with the International Register for Potentially Toxic Chemicals, whose headquarters are in Geneva, and which possesses a network of national correspondents throughout the world. The IRPTC data bank is particularly useful to developing countries, and GIFAP follows its activities closely.

A joint world industry (all industries)/UNEP conference was recently held in Versailles (France), with the very active participation of Dr. Mostafa Tolba, Executive Director of UNEP in order to establish what has already been accomplished on environmental safety and to define means of future collaboration.

GIFAP presented three exposes. Three members of the Executive Committee, the President, Dr. D. Wolf, and the Director General, contributed to the meeting.

With UNIDO, GIFAP collaborates in the definition of safety rules to be followed in formulation plants.

Finally, with the FAO, GIFAP has liaised in the drafting of a code of conduct for companies which export pesticides to developing countries. This code has been under discussion for almost two years. The final text will be presented to those concerned in the FAO in the near future. Governments in member countries have been consulted. It is difficult to say more now, other than that in the minds of the negotiating parties of the code, it is the safety of users which is primary, and GIFAP endorses this joint objective.

As far as the agrochemical industry is concerned, this can only be a voluntary code to which the interested companies may subscribe. Such a code is only a palliative and cannot replace a registration system which conforms to the conclusions reached at the FAO inter-governmental conferences held in Rome in 1977 and 1982. The objective of the industrial community remains that each sovereign country assumes its responsibilities by implementing a registration procedure in agreement with FAO guidelines.

GIFAP ACTION IN COLLABORATION WITH INTERNATIONAL PROGRAMS AND GOVERNMENTS

In Latin America under the auspices of the IICA (Inter-American Institute for Cooperation on Agriculture) located in San Jose, Costa Rica, GIFAP's Latin America Working Group organized several regional conferences regrouping neighboring countries and friends with the intention of reaching an agreement on the progressive adoption of the FAO guidelines on registration, classification, packaging and labeling. This action began in 1981 and is starting to bear fruit. Each country concerned is progressively bringing its legislation into line with the joint decisions. The practical implementation of this program and the necessary coordination with the companies concerned has been ensured by a GIFAP Regional Director for Latin America.

In Asia, collaboration goes on under the auspices of the Regional Network for the Production, Marketing and Control of Pesticides in Asia and the Far East (RENPAF), which is financially supported by UNIDO and UNDP programs which cover the following countries: Afghanistan, Bangladesh, Republic of Korea, India, Indonesia, Pakistan, Philippines, Sri Lanka and Thailand, and coordinated from the Philippines by Mrs. C. Gaston. The objectives of this program cover all aspects of pesticide safety, registration, distribution, formulation, application and residues. In very little time, positive results have been obtained and full collaboration with governments in countries which participate in this program has been obtained. The GIFAP Regional Director for Asia closely follows the activities of this program.

These two examples show that important progress may be made in a short amount of time, the only conditions being: goodwill on the part of governments; the necessary coordination ensured by an independent organization which must have sufficient financial resources as well as talent from the necessary experts.

If such programs were launched in Africa in the near future, GIFAP's collaboration would be ensured in advance. GIFAP in fact strongly desires this. I personally hope that this conference will not end before a decision in this direction is taken. All these programs in reality have one single objective — safety — pursued through different means.

DIRECT ACTION BY GIFAP

As an association of associations, GIFAP helps and encourages its member associations to promote safety and education campaigns.

The improvement in the conditions for the safe use in developing countries is achieved principally through education. This has been achieved in particular in Mexico, Brazil, India, Sri Lanka, and a number of other countries. GIFAP is in the process of drafting education programs based on safety in formulation plants regarding storage, transport, distribution and application.

GIFAP publishes many booklets, some illustrated, which stress the notion of safety. Many publications, in many languages, have reprinted these texts and illustrations. GIFAP would be only too pleased to grant permission to reprint extracts from these publications to the African organizations who request it.

DISCUSSION

Q. (A. Auma-Osolo). Director, Kenya National Academy of Sciences. Commented at length on roles of industry and government, on the one hand industry researching to open up markets while on the other the government is trying to control pesticide use. He suggested division of labor with the Academy assisting both sides in meeting needs of small farmers most of whom are illiterate. He appealed to industry to provide financial encouragement for the Academy to tackle problems, in particular regarding safety. He questioned Mr. Cosse, GIFAP, on FAO's attempt to interfere in the jurisdiction of independent states. Although code of conduct is voluntary it is seen as trying to tighten the screws on governments.

A. (Mr. Cosse). GIFAP. Doubted whether industry could finance research in different countries on safety aspects since they are already heavily using research to identify new pesticides, to obtain registration and to develop their products at farmer level in addition to activities to help farmers use their products. There is also the doubtful ethics of industry resourcing private institutions and universities which would then be more committed to toe the line of industry rather than that of the government. On the FAO Code of Conduct, the FAO can only be palliative and cannot take up the role of government registration. FAO does not make decisions. It is a forum for opinions, the decisions are made by the member states.

A. (D. Mukunya). Pesticide Board of Kenya. We are working with the Academy of Sciences and have consorted with them. We do not wish industry to fund our activities because we do not want to toe their line.

(A. El Sabae). Egypt. Commented on the need for institutes to exchange ideas and share experiences. He suggested that responsibilities should be confined to each body and the position consolidated before outside institutions requested to upgrade functions. He commented on GIFAP and PCA being in ideal position to avoid antagonism between industry and consumers, giving two examples: In one case a product had been banned by EEC but this product was still being exported. The second case

was where a human medical problem had been documented for a pesticide in Sri Lanka although laboratory animals had not shown symptoms, but the product continued to be recommended by manufacturers. He urged major companies not to supply such products before they are put on restriction or ban lists, and to provide clear and full picture for products and not to offer them at early stage of testing

A. (J. Cosse). GIFAP. Agreed totally and considered two aspects: risk/benefit and provision of new facts. Risk benefit analysis performed in originating country cannot be the same in importing country. It is impossible to have one worldwide risk benefit analysis. Importing country must have access to risk benefit data and the means to perform a local analysis but a good interpretation depends on competent toxicologists. On disclosure of new facts, if a company does not cooperate, GIFAP must be informed. He had not heard of the Sri Lankan example He supposed that it had been reviewed by the company and the data validated or invalidated. A company would normally be expected to comply with disclosure of facts in order to maintain its reputation. The local association can mediate and if necessary GIFAP can then be approached.

Q. (R. Neewoor). Mauritius. Is there anything regarding labeling and packaging in the 1982 Kenya Pesticides Act? In Mauritius, bottles are specially made and are returnable. There are three toxicological grades.

A. (G. Kibata). The act exists and if we can implement it, it will take care of many problems.

A. (D. Rocco). The PCA members do try and produce products and packages that are successful. Otherwise there would be no market. The Kenyan industry is new and there are many things we are not aware of. There is a lot of pressure from all sides and we are trying to follow recommendations of all people. All PCA products are sold with a label. We cannot control what happens far down the line but if we establish proper licensed pesticide sellers, it will help.

A. (G. Kibata). Addressed to GIFAP. It is all very well to make recommendations, the question is how to implement them. Regarding equipment for analysis, we have equipment but new equipment is being developed all the time. Could GIFAP and the UN try to develop an analytical laboratory?

A. (J. Cosse). GIFAP cannot take the place of government and agencies but it can invite people to see developed facilities. It is the object of this meeting to determine a clear distinction of tasks.

IV.
Pesticide Legislation

Pesticide legislation is needed in the region to avoid re-packaging problems.

COUNTRY PAPERS:

S.A. Goma — How Zambia handles pesticide imports without proper legislation.

E. Karamura — Problems of pesticide legislation in Uganda.

G.N. Kibata — Constraints in the implementation of Kenya's pesticide legislation.

S.S. Mlambo — Zimbabwe: Legislation and registration of pesticides.

TOPICAL PAPERS:

D. Bull — Pesticide advertising and labeling — A NGO point of view.

H.G. Alford — Regulation of pesticides in the United States.

How Zambia Handles Pesticide Imports Without Proper Legislation

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ABSTRACT

The discussions focus principally on the need for some measures of regulatory control with regard to the importation of pesticides, as well as for the control of conditions for local manufacturing and formulation of pesticides. The paper summarizes the legislation currently in force in Zambia and concludes that it is not adequate to deal with the problem posed by pesticides.

While the paper addresses only the Zambian efforts to regulate pesticides, its generic aspects thus have broad implications for developing countries. An important conclusion however, is that, in general, some measures of regulatory control are necessary to deal with more complex problems posed by the internationalization of trade in chemicals. However, the government's administrative actions, coupled with close working relationship between industry and governments bodies, would go a long way in dealing with specific problems posed by chemicals generally and pesticides in particular.

INTRODUCTION

All pesticides used in Zambia, as in most developing countries, are imported either as finished products or as raw materials which are then formulated locally, into usable products. Recent estimates indicate that approximately 25% of the world pesticide market is used in developing countries, mainly on cash crops. However, it is expected that over the next one or two decades the consumption of pesticides by developing countries will increase considerably.

During the pre-independence period and immediately after independence, agriculture in Zambia was relegated to a poor second as more emphasis was placed on mineral production. Up to now mineral production still accounts for 90% of Zambia's foreign exchange earnings. However, with the prices of copper and other minerals dropping to the lowest levels, the present government has formulated a development strategy based on increase in agricultural production. The two basic means to increase agricultural yields are the use of selected, high yielding varieties of crops and the reduction of environmental constraints that hamper production through application of pest management (including the use of pesticides), fertilizers, irrigation schemes, approved storage, etc. With the government economic policy placed firmly on agriculture, there has been an obvious increase in the consumption of pesticides. The public sector also consumes a substantial volume of imported pesticides.

According to the *Zambia Monthly Digest of Statistics* for December, 1984, issued by the Central Statistical Office (CSO), pesticide imports for the years 1981, 1982 and 1983 cost K2,100,804; K2,784,008; and K3,813,095 respectively. Aid from bilateral agreements also brings in a substantial amount of pesticides.

NEED FOR PESTICIDE LEGISLATION

Throughout the world the use of pesticides is becoming an increasingly necessary operation in the consistent search for improved crop production.

In view of the complexity of the pesticide industry and trade, it is important for developing countries to enact laws to regulate the importation, distribution and use of such pesticides so as to ensure that they pose no hazard to man and the environment. Governments must play a leading role in legislation on pesticides and ensure that each pesticide product is registered in accordance with the laws and regulations before it can be made available for use.

In addition to registration schemes, it is desirable to enact specific laws and regulations to control importation, distribution and use of pesticides.

CURRENT LEVEL OF CONTROL IN ZAMBIA

At the moment, Zambia has no specific laws to control importation, registration, distribution and use of pesticides. However, we operate a strict import permit system which requires companies to obtain a permit before they are allowed to bring in either raw materials or pesticide products.

For importation purposes, the Ministry of Commerce and Industry has set up a Drug and Chemical Approval Committee which receives applications for imports of drugs and chemicals (including pesticides) from companies or individuals. The Committee vets the applications and recommends to the Ministry of Commerce and Industry what products may be brought into the country including the specification of the quality of such items. The Committee is composed of top level officials of the following government departments: Directorate of Agriculture; Directorate of Pharmaceuticals (Ministry of Health); Food and Drugs Board (Ministry of Health); Directorate of Veterinary Services; Department of Customs; and Foreign Trade Department of the Ministry of Commerce and Industry.

Although the Committee only gives recommenda-

1 Kwacha = US$ 0.16

tions, they have always been carried out by the Ministry of Commerce and Industry. Once the decision has been made as to what product to be brought in by a company or government agency, appropriate foreign exchange is allocated to the applicant. Because Zambia, like other developing countries, is in difficulty over balance of payments, administrative regulations on the imports of pesticides are strictly adhered to.

The Committee operates with the following powers

- To provide administrative and legislative support for ensuring quality and availability of pesticides which are appropriate to the needs of the country.
- To reduce the prices of pesticides and to ensure procurement of raw materi[illegible] the most competitive prices.
- To keep out useless, banned and harmful pesticide products.
- To promote local production of finished goods.
- To ensure coordination among various administrative branches of government in respect of pesticide control and supply system.

Although Zambia does not have any specific legislation for the control of pesticides use, the following statutes have proved successful in controlling their use:

The Control of Goods Act — Cap 690
This Act gives power to the President to provide, by regulation, the control of the distribution, disposal, purchase and sale and wholesale and retail prices of any manufactured or unmanufactured commodity for the control of imports and exports into Zambia.

The Pharmacy and Poisons Act — Cap 536
This Act may classify a particular pesticide as a poison in Part II of the schedule and such classification would be subject to control in terms of sale.

The Food and Drugs Act — Cap 535
Has got provisions to control the import of foodstuffs which may have pesticide residue in excess of the prescribed maximum levels. The Zambia pesticide industry has been very responsive to workers' education and there exists mutual responsibility between them and government agencies in this field.

CONTROL THROUGH INTERNATIONAL AGENCIES

Zambia, as a member of the United Nations system through its specialized agencies, has actively taken part in international work related to pesticides. Zambia participates in the following United Nations progams related to chemicals (including pesticides):

UNEP's Provisional Notification Scheme for Banned and Severely Restricted Chemicals
Zambia has designated the Food and Drug Board as the national authority for the above scheme. The Board in turn works closely with the Drug and Pesticide Approval Committee.

In addition to the above scheme, Zambia works closely with International Register for Potentially Toxic Chemicals (IRPTC) and the International Program on Chemical Safety (IPCS) as well as the ILO program on workers' health.

FUTURE NEEDS

It is apparent that the current legislation on pesticide control is inadequate to deal with all problems involved. Although administrative safeguards have been exercised, there is need for a comprehensive legislation for control of pesticide products. The Environmental Protection Bill has therefore been drafted which covers all aspects of environmental protection including water, industrial waste, noise, radiation and chemicals. The section dealing with chemicals is drafted in such a manner as to be comprehensive enough to take care of all matters regarding pesticides including importation, manufacture, distribution, usage and labeling.

The procedure in enacting legislation begins with the layman draft of the bill by the sponsoring or client ministry, which is submitted to Cabinet who must approve in principle the objectives and necessity of the proposed legislation. The draft is then presented to the Ministry of Legal Affairs for review and vetting before the draft is published in the official gazette after which the sponsering ministry takes it to parliament. All these stages have been completed for the Environment Protection Bill and we are waiting for its presentation to Parliament.

Problems of Pesticide Legislation in Uganda

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INTRODUCTION

Until the break-up of the East African Community, all pesticides and the bulk of agricultural chemicals in Uganda were handled by the East African Pesticide Control Organization (EAPCO). This organization was responsible for screening, analysis and registration of pesticides being imported into the region. With the break-up of the Community, Uganda lost access to this very essential service. Within the country, the Pharmacy and Drugs Act of 1970 was the closest legislation that could control agricultural chemicals, and pesticides in general. The Act defines drugs to include all agricultural chemicals and the Commissioner for Agriculture was a member of a technical committee of the Pharmacy Board which administered the Act in close association with the Ministries of Health and Animal Industry. The Pharmacy Board which consists of the inspectorate and registry organs, consistently concentrated on human and animal drugs, but malpractices increased unabated with regard to agricultural pesticides.

This Act (still in force) lacks specific detail on agricultural pesticides particularly agricultural crop pesticides. Little is mentioned about labels, storage, transportation, buildings, residues and the effect on the general environment. No mention is made of application precautions, such as protective clothing, so vital to the safety of the people handling them or of advertizing procedures which have largely been responsible for misinforming farmers.

As a result of lack of effective control, a lot of malpractices have occurred. Numerous agricultural pesticides of unknown purity, without labels and largely of doubtful effectiveness, found their way to the farmers. As the Pharmacy and Drugs Act lacks not only a teaching component but also a self-evaluation mechanism, it is impossible to find out the actual effect of these chemicals particularly at the subsistence farm level. Taking advantage of a free-market situation in Uganda, and ineffective legislation, the pesticide industry which is not required by law to declare or verify the purity or effectiveness of the materials it is selling, has often availed to farmers chemicals that are not effective. In addition, the country's valuable foreign exchange estimated at over US$ 100 million is being wasted annually on products of unknown quality.

NEED FOR LEGISLATION

The need for an effective legislation has been voiced time and again by extension staff and environmental and other conservation groups. Most important is the need to know what happens to agricultural chemicals upon arrival in Uganda. How much is imported, where and under what conditions the chemicals are stored and how they are transported. Safety precautions should also be taken into consideration.

OBJECTIVES

An effective legislation should have well-defined objectives so that it is possible at some stage to evaluate its effectiveness. When formulating objectives, it is necessary to look at the system as a long pipeline with branches. The pipeline begins at manufacturers to distributors sellers and ends at the farm level. Viewed in this way the system will have identifiable linkage points that can be patched by a legislation. The country therefore would need to examine its unique system and identify the linkage points that need patching. Objectives then would be formulated to enable evaluation of the system on the basis of those linkage points. If the legislation is made in such a way that it is also flexible, then depending on the results of regular evaluation, the objectives can be reviewed and re-stated to cater for the dynamic nature of the system.

RESPONSIBILITY OF LEGISLATION

Much has been said about the responsibility of governments to peoples' safety. The responsibility of the industry in pesticide use and safety cannot be over-emphasized either. Uganda, like most developing countries lacks the necessary infrastructure to develop an effective legislation. Besides, resources, in terms of technical equipment and manpower, are lacking for this relatively new science. The industry could do a lot more than those actions that are only related to marketing. Educational and extension services as well as analytical facilities could be provided by the industry. Presently, there is lack of basic information about the pesticide system. This information is required so that viable decisions can be made. The industry could assist or cooperate with the government in the task of gathering basic information or setting up analytical facilities. Uganda indeed has the framework for such facilities, but over the last few years, these have needed rehabilitation.

The industry in Uganda, although comparatively small at present, would assist government efforts by forming an association. This association would then serve as a reference for joint discussions on matters of mutual interest. The association would also impart discipline and responsibility to its members while at the same time discussing with the government how best and effectively the system could be improved. Some companies are already engaged in some work in Uganda but this is not only related to marketing but also overlaps with duplication of effort. Such wasted effort would not be there if there was coordination between government on one hand and industry, represented by an association, on the other.

Constraints in the Implementation of Kenya's Pesticide Legislation

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ABSTRACT

The East African region has been duly concerned about the need to regulate pesticides over the last 20 years. However, attempts to implement the East African pesticide legislation were frustrated by lack of financial support and apathy among the member governments. The Government of Kenya through the Ministry of Agriculture has since 1977 enacted legislation on pesticides through the Pest Control Products Act No. 4 of 1982 (Kenya Government 1982). The Act allows for the establishment of a management system for pesticides during manufacture, sale and use. A management body, the Pest Control Products Board, was appointed to undertake those responsibilities. The board would effect the registration of pesticides and endorse use patterns in accordance with good agricultural practices. It was envisaged that the board would establish an executive and technical infrastructure for effective implementation of the Act. The technical department of the board which is hereafter referred to as the "technical secretariat" has never been established.

This and other fundamental issues that affect the effectiveness of the board, its finances and facilities have not been resolved. This paper attempts to highlight some of those constraints which have delayed the implementation of pesticide legislation in Kenya. It also underscores the magnitude of the responsibilities which have been vested on the board but remains optimistic about eventual successful implementation of pesticide legislation in Kenya.

INTRODUCTION

Since 1965 when all the East African countries were independent, pesticide regulation has been an issue of great concern. However, it was not until 1969 that formal legislation was endorsed under the aegis of the now defunct East African Community. The then East African Legislative Assembly passed the first pesticide control bill which became the Control of Pesticides Act No. 11 of 1969 (amended via No. 2 of 1970).

In 1971, the East African Pesticides Control Organization (EAPCO) was established as a body corporate. The EAPCO which was based in Arusha was mandated to implement the Act on behalf of the member countries. However, the establishment of EAPCO never became a reality as the organization was progressively beleaguered by diverse problems of management, finances and lack of support from the three member-country governments.

THE PEST CONTROL PRODUCTS ACT, 1982

The regional approach thus having been frustrated, the Government of Kenya, through the Ministry of Agriculture, initiated fresh efforts to establish pesticide legislation on a national basis in 1977. This culminated in the preparation of the Pest Control Products Bill (No. 2 of 1982).

During the preparation of that bill, exhaustive reference was made to several documents and related legislation. Particular reference was made to the FAO Plant Production and Protection, Paper 28, May 1981; FAO report on AGP: 1977/M/9, October 1977; the Control of Pesticides Act No. 11 of 1969, 1970 Chapter 36; the East African "Pest Control Products Act, Chapter 10, 1968-1969".

The latter legislation was found particularly pertinent due to its simplicity and precision. The exercise culminated in the Pest Control Products Act (No. 4 of 1982) which became law on 25 May 1982.

As provided by the Act, the Minister for Agriculture subsequently appointed a management board, the Pest Control Products Board (PCPB), on 19 May 1983. The board consists of 14 members, the chairman and at most 5 ex-officio members. The PCPB was inaugurated on 17 August 1983, and charged with the responsibility of interpreting the Act in order to provide the necessary machinery for its implementation.

IMPLEMENTATION OF THE ACT

As had been envisaged during the preparation of the bill, the board which would largely consist of senior public servants would be unable to implement the Act through regular board meetings. It had been appreciated and proposed that the board would have a technical establishment to deal with the routine duties and responsibilities as required by the Act. The draft bill had implicitly proposed the establishment of a "technical secretariat" to serve the board in that capacity. Unfortunately, the clause relating to the establishment of the technical secretariat was conspicuously omitted in the Act. However, the legal department assured the ministry that the provision of the board presumed that it would establish a technical executive body to implement the Act on their behalf in view of technical requirements of the Act.

Similarly, the three-term FAO consultancy reports made propositions for establishing an elaborate executive secretariat and strongly recommended the reinforcement of the existing analytical capacity for pesticides (FAO/Kenya TCP/KEN. 1981, 1983, 1984).

At the board's inaugural meeting, the chairman, Prof. D.M. Mukunya, presented a preamble paper on the proposed modus operandi for the implementation of the Act (Mukunya, 1983). He elaborated

on the infrastructural requirements and expected functions of the board as relates to the implementation of the Act. He underscored the need to establish a fully fledged secretariat which would perform technical and executive duties on behalf of the board. However, those views did not receive the full support of the parent ministry at that time. It was nonetheless suggested that the board should start its operations in a modest way and gradually attain the desired infrastructural excellence when funds became available.

From that modest beginning, the PCPB and a few members of staff from the Ministry of Agriculture set out to make pertinent regulations relating to registration of premises, pest control products, labeling, importation and exportation (legal notices 45, 46, 89, 146). The board has established procedures related to the implementation of the Act, particularly finances, staff and office requirements. In addition, the board and the parent ministry have negotiated on other fundamental issues relating to the establishment of a technical secretariat.

The board received a nominal financial grant from the Ministry of Agriculture, most of it was used on recurrent expenses excluding personnel emoluments. A skeleton staff to service the board was also provided (Kenya Gazette notice No. 3715, September 1984). These appointments did not however provide the core staff to constitute the expected technical secretariat, but only provided for a secretary, two inspectors and an analyst.

Having observed that a year had already elapsed since the Board was inaugurated, the board, through the Minister for Agriculture, announced the commencement of the Act as from 1 October 1984.

It was however regrettably noted that the implementation of the Act would still be frustrated by shortage of staff, funds and office facilities. The renovations to the Board's building had just started and were expected to be complete by early 1985. Other pending issues relating to the status of the board vis-a-vis the parent Ministry were still unresolved. Would the board be semi-autonomous, capable of hiring its own staff or would it be merely an advisory body operating under the parent ministry. Would there be a technical secretariat and to whom would they owe their allegiance.

These questions still underlie the fundamental issues which have not been resolved and would establish the credibility of the Pest Control Products Board.

The mandate of the Board is however clearly defined in the Pest Control Products Act. The Act, which is a legal instrument, established a board "to regulate the importation, exportation, manufacture, distribution and use of products used for the control of pests and of organic function of plants and animals and for connected purposes". The board's main function is therefore to establish a system of management and registration of pesticides in Kenya.

In spite of the initial constraints, the new staff who were allocated to the board with the assistance of a very devoted chairman, have been able to start a program for registration of premises which deal with pesticides and will soon start scrutinizing data which has been submitted by industry in support of registration of pest control products.

It would be an oversight not to make some salutory remark about the pesticide industry. Contrary to what would have been expected of the industry in response to a legislation that was likely to curtail some of its freedom in the pesticides trade, we have received tremendous support for registration. We are therefore optimistic that legislation on pesticides in Kenya will eventually succeed.

CONCLUSION

It must be appreciated therefore that the handicaps are still many and the achievements to date are far behind schedule. The staff complement to serve the board in the onerous task of pesticides registration, inspection and analysis remain to be identified. Other fundamental issues relating to the identity and powers of the Board, the executive infrastructural establishment and financing are but a few of the operational areas which still need to be resolved. Having started from a modest beginning to undertake a formidable task, it is the aspiration of the Pest Control Products Board that these initial handicaps will soon be problems of the past. The board would at best hope to establish a machinery to implement the Act with both local and international credibility. It would therefore continue to borrow heavily from the experience and possibly solicit for expertise from international regulatory organizations and similar legislative bodies.

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DISCUSSION

(Dr. Mukunya), Kenya: By way of comment observed that the Kenya legal process was a lengthy one. He observed that the Board was facing problems due to lack of competent staff in key positions. Training was required to include users.

Q. (C. Khamala), Kenya: Observed that it was a mistake to enact a law without an executing machinery or technical arm, and saying nothing about export or import. He recommended that an amendment be proposed immediately.

A. (D. Mukunya), Kenya: The government does not act so fast as the need arises. The products on market were imported before the law was enacted. There are over 500 products to be worked on, which is a slow process.

Q. (Janice Jensen), USAID, Zambia: Inquired as to where toxicological information can be obtained.

J.B. Jensen: In reply referred to the IRPTC booklet as having all the details. Direct contact also could be made with either UNEP or IRPTC.

Q. (El Sebae), Egypt: By way of comment, observed that there are so many UN organizations, WHO, FAO, UNESCO, UNICEF, all having departments on pesticide management. These would need to be coordinated.

A. (H.B. Jensen): Coordination actually exists among UN agencies but also national schemes must realize they have a role to play such as building up their own information network and identifying specific national authorities to liaise with IRPTC.

Q. (El Sebae), Egypt: Inquired whether it would be possible for IRPTC/UNEP to obtain/have access to confidential data and publish it for use by consumer countries.

A. (H.B. Jensen): This would be desired but at present it looks hard.

Zimbabwe: Legislation and Registration of Pesticides

by
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ABSTRACT

In Zimbabwe no agricultural or veterinary pesticide may be sold or distributed unless it is registered in terms of the Pesticide Regulations of 1977, under the Provisions of the Fertilizer, Farm Feeds and Remedies Act (Chapter III) of 1952 and placed in Group II or III of the Hazardous Substances and Articles Act (Chapter 322). The purpose of the 1952 legislation was to regulate and restrict the importation and sale of under-grade remedies thus protecting the farmer from commercial exploitation. The implementation of these regulations has helped prevent the country from becoming a dumping ground for unwanted agro-chemicals and keeping highly poisonous pesticides from the small-scale farming sector. Farmers are also trained on the use of pesticides and on safety precautions, including the use of protective clothing.

INTRODUCTION

Before pesticides are sold or distributed in Zimbabwe, they are required to be *registered* by the Ministry of Agriculture in terms of the Pesticide Regulations of 1977, under the provisions of the Fertilizer, Farm Feeds and Remedies Act, (Chapter III) and placed in Group II and III of the Hazardous Substances and Articles Act (Chapter 322). This requirement ensures that only pesticides whose efficacy and toxicity have been thoroughly investigated and found effective and safe, will be sold. Another safety valve is exercised by the Agricultural Chemical Input Priority Committee which determines what pesticide will receive foreign currency allocation and what quantity will be imported for each pesticide. Ministry of Agriculture officials who chair meetings of this committee scrutinize the lists of chemicals submitted by the Agricultural Trades Association to ensure that only fully-registered pesticides are considered for foreign currency allocations.

Pesticide is defined to include all those chemicals that are used primarily for the control of insect and other invertebrate or vertebrate pests; bacterial or virus diseases of plants; weeds; and growth regulation and growth inhibition.

Any mixture of a pesticide with a lacquer, paint, spray, fertilizer or any other substance, for the control of pests and diseases, is also required to be registered under these regulations. Registration is applied for, triennially, on or before 31 March.

The purpose of registration is to ensure safe and efficient use of pesticides in the interests of the user (farmer), the consumer and the general public who are concerned about hazards in handling, residues in food, and possible contamination of the environment.

The dealer is also protected from unfair claims for competitive products.

Application for registration is made by a resident representative of the company manufacturing the chemical, who then becomes responsible for marketing the product in Zimbabwe in accordance with the regulations. All commercial formulations of pesticides throughout the country must be registered. If the weight or composition of the active ingredients or any other component of the pesticide is altered in any way from the declaration of the original registration form, the product must be re-registered.

A registration form (P1) is filled in triplicate and sent to the Pesticide Registering Officer with any other relevant data. Also, where applicable, three copies of the label should be provided, as well as any advertisement to be used to promote the sale of the pesticide and, should the registering officer require it, two samples of the pesticide. Applications for registration are scrutinized in detail to ascertain the validity of claims made.

Information on physical properties and toxicology will be accepted from recognized published sources. Claims for the control of agricultural and horticultural pests accepted by the agricultural departments in countries with similar climates to our own will be viewed favorably. Experiment data in support of claims made must be derived from experimentation stretching over at least two or three seasons with research conducted under varying climatic conditions in the country. Claims for the control of green-house and household pests may be substantiated by work carried out in country or data from other countries provided the species and climatic conditions are identical with those of Zimbabwe.

Registration of a pesticide is completed when a certificate of registration and a registration number are issued upon approval of the label submitted by the applicant.

It is essential that the full chemical composition and amount of each component of the formulation are given in the application form. Registration may be withheld if data is incomplete.

COLOR CODE FOR PESTICIDES

The registering officer, following a decision by the Hazardous Substances and Articles Committee, will assign a color to each commercially available pesticide. The color code is based on, mainly, acute oral LD50 of the technical material; the strength of the formulation; and the persistence of the material after application.

Acute oral LD50 data is taken from the Pesticide Manual published by the British Crop Protection Council or other published sources. They are color-coded as follows:

Green Pesticides
Formulations with an acute oral LD50 of over 200 I which can be used without danger in the home or where stated as admixture to grain or other stored produce for human or animal consumption. These can be offered for sale by any shop or store.

The word, "caution" must appear within the green triangle and the words "harmful if swallowed" beneath the base of the triangle.

Amber Pesticides
Formulations with an acute oral LD50 of between 50 and 2,000 I which can be used without danger in home gardens and for external use about the home.

These can be offered for sale by a retailer if a special part of the shop or store is set aside specifically for display, storage or sale of dangerous substances.

The word "danger" with the skull and crossbones symbol must appear within the amber triangle, and the world "poison" beneath the base of the triangle.

Red Pesticides
Formulations with an acute oral LD50 of between 101 and 500. Their use should be generally restricted to horticultural, agricultural, health or industrial pest control operations and only applied in the home by a recognized pest control operator where specific precautions are taken and the insecticide has been registered for a particular purpose.

These may only be sold by a licensed dealer where a special part of the premises has been set aside specifically for display, storage and sale of dangerous substances.

The word "danger" with one skull and crossbones symbol shall appear within the red triangle, and the words "dangerous poison" beneath the base of the triangle.

Purple Pesticides
Formulations with acute oral LD50 of up to 100.

These may only be sold to persons whose business, profession or trade utilizes them. They may only be sold by licensed dealers where part of the premises is set aside for the sale of dangerous substances. The dealer must keep a poison register of all sales of this group of pesticide, each sale being counter-signed by the purchaser or his nominee, and the farm licence number noted.

The word "danger" with one skull and crossbone symbol should appear within the purple triangle, and "very dangerous poison" beneath the base of the triangle.

LABELING

Labels must be printed in English or in Shona and Ndebele if the sales outlets are mainly in communal areas.

On the front panel of the label it should be stated whether the pesticide is intended for agricultural, horticultural, home garden, storage, indoor, public health or other uses.

Rates of application should therefore be indicated according to the primary use, based on a standard of 10 I total spray volume.

Agricultural usage will be based on a standard of 100 I total spray volume for conventional ground spraying.

Application rates will be expressed as spray to run off, light cover spray, or soil drench.

Measures in tea spoons or table spoons should be avoided where possible and it is recommended that plastic cups or measures should accompany small packs. This ensures that the ordinary farmer uses correct measurements.

For home and garden use, the range of pack size will generally be: liquids — 100 ml to 1,000 ml; solids — 100 g to 2.5 kg.

Safety intervals should be indicated in bold type or in color. Labels must be approved before they are printed in bulk. A printer's proof of the completed label must be sent to the registering officer.

All pesticides labels must have a triangle of approved color, centrally placed on the label, equidistant from either vertical side. The size of the triangle must not be less than 1/20 of the entire label.

Where packs involving plastic bags are produced, the placing and size of the triangle will be a matter for discussion with the registering officer. Each case may be decided individually.

It is important that all labels be fully metricated. It is suggested that the 1,000 cubic feet volume be replaced by 30 cubic metres. The term "w/w" should be replaced by the term "mass/mass".

Pesticide firms are also reminded that all pesticide advertisements should be submitted to the registering officer for prior approval before publication or showing.

The colored triangle indicating the toxicity of the formulation will correspond exactly to the color as illustrated in Coates Color Pack, 1970. Neosett Letter-Press Inks, viz:

- Purple — IMPERIAL PURPLE LT 3
- Red — MID RED LW 12
- Amber — DEEP ORANGE CHROME LP 2
- Green — EMERALD GREEN LS 8

It is recommended that the standard phrases as set out in working documents Nos. 7, 8, 9, 10 and 11 of the United Kingdom "Pests Safety Precautions Scheme, as agreed between government departments and industry" be used where applicable.

It is suggested that where a pesticide is mainly sold for the purpose of admixing to grain for the control of stored-products pests, that there should be a printed background motif to the label, e.g. shelled maize or sorghum.

COLOR CATEGORIZATION OF PESTICIDES

The color of the triangle is allocated according to the lowest oral LD50 for rats and according to the dermal and inhalation rates; all this is discussed at the

* The Oral LD50 is that single dose expressed in mg/kg of body weight which when given by mouth kills 50% of the animals under test.

Hazardous Substances Meetings and only then is the color category decided upon.

The colors have the following limits — green being the lowest toxicity and purple being of the highest toxicity.

TABLE 1
TOXICITY COLOR CODE

Color category	Oral LD50 (rats) mg/kg
Green	200 and above
Amber	501 2000
Red	101 500
Purple	0 100

Purple: This pesticide is sold only for use by qualified personnel and may not be used by the general public. (Acute Oral LD50 for 0-100 mg/kg body weight.)

Red: This pesticide is not as restricted as the purple category but is still restricted from use in the home or home garden. (Acute Oral LD50 for rats 101-500 mg/kg body weight.)

Green: This pesticide may be sold for use in the home but it should still be used with caution as sufficient quantities can be very dangerous. (Acute Oral LD50 for rats is greater than 2,000 mg/kg body weight.)

No pesticide can be regarded as safe and it is imperative that the user must at all times follow instructions and observe all the necessary precautions stated on the label. Misuse of pesticide may lead to crop failure, scorching or killing of plants, and most important, ill health or even death of the user.

The policy on organochlorine insecticides, developed five years ago, seeks to gradually phase out all chlorinated hydrocarbon insecticides. Already DDT is banned for agricultural use. Its use is now limited to mosquito and tsetse fly control. The use of Dieldrin is now strictly restricted to roofing buildings and the control of ants and termites.

New regulations due to come out under the Hazardous Substances and Article Act, will require every pesticide applicator to wear protective clothing during handling and application. The type of protective clothing used at any one instance will depend on the formulation and category of the pesticide being used. The intense heat resulting from the prolonged wearing of non-aerated protective clothing will obviously make the implementation of the regulation difficult.

CONCLUSION

Regulations alone cannot guard against industrial disasters. They have to be enforced by professional people who are well informed about all aspects of production, handling (including loading onto trucks and mixing or dilution) and application of pesticides. Above all, all workers who are employed in the agrochemical industry must be thoroughly trained and drilled in how to handle dangerous chemicals and to maintain machinery during the course of packaging, transportation mixing, application, storage and disposal of pesticides. Fatalities will always occur as long as the necessary precautions are not taken. The Zimbabwe pesticide regulations, particularly the categorization of chemicals whereby red and purple triangle agrochemicals are recommended for use in communal areas have been effective in safeguarding lives and saving the country from being used as a dumping ground for unwanted agrochemicals.

DISCUSSION

Q. (Dr. Kiss), Washington, USA: Is it possible to have a standard color coding scheme?

A. (S. Mlambo): This has been a problem and a lot remains to be done.

Q. (A. Balla), Sudan: In the Sudan, research one efficacy is carried out by national institutions, who does this in Zimbabwe?

A. (S. Mlambo): Due to lack of some analytical equipment, both the national research institutions and agrochemical companies can carry out tests.

Q. (A. Balla), Sudan: How important is information from the exporting countries and firms?

A. (Dr. Mlambo): If for a particular analytical process, equipment is lacking in Zimbabwe, results from other laboratories under similar ecological set-up can be accepted.

Q. (D. Mukunya), Nairobi University: By way of comment noted that pesticide are toxic and legislation has a limit. What was required was a massive training programme.

A. (S. Mlambo): A great deal of emphasis is put on training but only a small proportion of it involves peasant farmers, the training of extension staff dominates.

Q. (A. Obel), Nairobi: Labels have at times carried outdated information, especially expiry dates. The date of manufacture should be given in case of pharmaceuticals.

A. One of the notable problems was long distances between exporting countries and importing countries, consignments taking as long as 9-12 months in shipment.

Q. (R. Neewoor), Mauritius: By way of comment noted that an effective training and has been employed in Mauritius whereby a "pesticide week" is instituted on radio, television, posters and newspapers, explaining pesticide management.

A. (N. Silk), Zimbabwe: There is a similar arrangement in Zimbabwe with a programme "Agritex" which is a daily 3-hour agricultural news program on pesticide.

Pesticide Advertising and Labeling — A NGO Point of View

by
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INTRODUCTION

We all know or have heard of people like Kassim — a victim of fatal pesticide poisoning. There are at least 10,000 like him every year. I met his son, Nasruddin, in Malaysia, a few years ago. He was reading the autopsy report on his father. It has been conservatively estimated that about 375,000 people are poisoned by pesticides each year, 10,000 fatally. Pesticides promise to be of help in increasing agricultural production, but if benefits are to be achieved without excessive costs to humans and the environment, pesticides need to be carefully chosen, effectively controlled and judiciously used. Otherwise, the benefits to agriculture will not be achieved, while side effects will continue to increase.

Problems and hazards of pesticide use can only be prevented if users have access to reliable and adequate information, through such channels as official extension services, labels, and company sales promotion.

Extension services in the Third World are usually inadequate, over-stretched and under-financed, therefore safety and efficiency in pesticide use depends to a large extent on labeling and advertising practices. Both should be used as educational media, not just as means to sell a product and make a profit. This is a challenge and a responsibility for pesticide manufacturers and distributors.

It is necessary to bear in mind that information is useless unless it is usable. Instructions to "Keep in a cool place", "wash" or "wear protective clothing" may not be usable in many Third World situations. Pesticides which require unusable instructions should preferably not be available. If they are available, they should be fully and properly labeled — at least users will then know that impossible precautions are necessary for safe use.

A technology which cannot be properly used is classically inappropriate. If a highly inappropriate technology is marketed, it requires the highest possible standards of responsibility. Such standards cannot consist only of complying with law, where law is insufficiently developed. For this reason, the need for internationally agreed standards is very great, and a code like the one being developed by the FAO must be strongly supported.

LABELING

A label is the final and most direct instruction to the user. It should give all necessary information for safe and effective use. Yet labels are often inadequate or inaccurate. One survey in Mexico revealed that 50% of the labels examined had some incorrect information. Warnings and precautions required by law in pesticide exporting countries often fail to appear on labels in Third World countries for the same products by the same companies. If the recent (7th) draft of the proposed FAO code is adopted, it is likely that the majority of Third World pesticide labels will infringe it. Existing ILO standards are infringed daily. The ILO *Code of Practice on Safety and Health in Agricultural Work*, first published in 1965, states that:

"523. (1) All containers of toxic substances should state on the label:

- The safety precautions to be taken in handling and use
- The nature of the early symptoms of poisoning
- The immediate first aid method to be instituted in the event of over-exposure and suitable antidotes, and
- An indication of the methods of safe disposal of containers.

(2) These labels should be approved by the competent national authority."

In 1977, ILO published guidelines on the safe use of pesticides which add to the above that labels should be in local language, that the active ingredient should be specified and that manufacturers should ensure that every product distributed "bears a label which is in accordance with the requirements of the national authorities, and which gives in the language of the region, comprehensive instructions for safe use, warns of possible hazards, specifies the active ingredients and gives guidelines for first aid in case of poisoning (including antidotes).

Key information that should be contained on a label includes:

- Active ingredients (common name) and percentage
- Safety precautions, including protective clothing
- Nature of poisoning symptoms
- First aid/antidotes
- Disposal of containers/warning against re-use
- WHO or equivalent hazard classification
- Batch number
- Formulation date
- Pre-harvest interval
- Use information.

Below are examples of labeling which fails to conform to these standards.

A label for Endrin 19.5% E.C. by Shell Chemicals from the Philippines: Endrin formulations are banned for almost all uses in Europe and the USA and if used, adequate protective clothing would have to be recommended. In the USA, a special warning to female users would have to appear on labels. This Philippines label, in English only, contains inadequate precautionary information and no warning to female operators.

The second is a label for "Endrex 20" marketed by Lankem (a Shell associate) in Sri Lanka. The active ingredients are specified only by the chemical (rather than common) names. The actual active ingredients are enthyl parathion and diazinon. In view of the extreme hazard of ethyl parathion, the precautions on this label are inadequate. In the UK, for example, protective clothing would be required by law, yet such clothing is not recommended in Sri Lanka.

Although I believe that Kenya has better control of the situation than many other countries, I will give a few examples where some improvement is needed.

The Pesticide Chemicals Association of Kenya, has developed a code of conduct and states the following concerning labeling:

> Members will comply with the Pesticides Control Bill which details labeling of agricultural pesticides and related chemicals which have been enacted by Government and which contain recommendations regarding lay-out and content, print size and the placing of the information and phrases that are required by law. In recognition of the acceptance of this Code of Practice, members may utilize the logo of the Association on their labels. Proposed uses of the logo must be approved by the Executive Committee.

The Kenyan law referred to above, The Pest Control Products Act of 1982 states:

"15. The Minister may, after consultation with the board, make regulations . . .

(h) respecting the packing, labeling and advertising of pest control products."

Table 1 shows pesticides purchased locally (March 1985); all of which contained the logo of the Pesticide

TABLE 1.
COMPARISON BETWEEN SAMPLE LABELS AND INFORMATION THAT SHOULD IDEALLY APPEAR ON A LABEL

Pesticide	Language	Active ingredient	Precautions	Poisoning symptoms	First Aid	Disposal	WHO Class	Batch No.	Formulation data	Harvest interval
Rentokil Termite Nest Concentrate	English only	Endrin 2	Only states wash hands	No	No	No	No (IB)	No	No	N/A
Metasystox R.	English Swahili	Demeton-S -Methyl Sulphone 25%	Insufficient Does not mention use of protective clothing	No	No Lists antidote	Destroy Empty Containers But it is glass!)	No (IB)	No	No	Yes
Dedevap	English Swahili	Dichlorvos 50%	Insufficient	No	No lists antidote	destroy No (as above)	No	No .(IB)	No	Yes
Gusathion	English Swahili	Azinphos-methyl	Insufficient	No.	No lists antidote.	"	No (IB)	No	No	Yes
Murphy Ant Killer	English/ Swahili	Not specified	Very little	No	No	No	No (?)	No	No	N/A
Rentosec	English/ Swahili	Not specified.	"Poison - not to be taken"	No	No	No	No (?)	No	No	N/A

Chemicals Association. In all cases the labels did not meet the various standards set up by ILO and WHO and envisaged in the FAO code. All four of the pesticides for which the active ingredient could be identified, are specified by WHO (in their technical product form) as "highly hazardous" and are banned or severely restricted in the USA UK. The table compares the actual information on each label with the recommended information listed above based on the various agency guidelines. If no information in a given category is given on the label then the word "NO" is written. The WHO classification for the technical product appears in parentheses if not listed on the label.

There can be no doubt that labeling can and should be improved, especially under Third World conditions, using local languages or symbols. The discussion of labeling, though, confirms the conclusion that many pesticides are on sale in Third World countries which cannot be safely used according to the instructions even if these are full and correct. If such pesticides are available, users need to be aware of the conditions necessary for safe use before they buy the product, otherwise they must return, dispose of, or use it. Return may not be possible and disposal or use are likely to be hazardous. This is why advertising is so important.

ADVERTISEMENTS

Advertising is very widespread in the Third World. A wide variety of methods are used including bill boards, ends of houses, street signs, radio, television, cinema, cars with loudspeakers, and many others.

Clearly, advertising is a major and widespread source of consumer information. High standards are essential to give consumers full safety information.

There are very few controls on advertising and promotion, let alone specific controls which deal with the special problems of promoting pesticides. Those which do exist are poorly enforced and insufficiently specific. The International Chamber of Commerce (ICC), for example, publishes an international code of practice. This states the basic principle that:

> All advertising should be legal, decent, honest and truthful. Every advertisement should be prepared with a due sense of social responsibility.

The ICC Code recognizes that small print in advertisements cannot provide escape from these obligations.

> Advertisements should be judged by their likely impact on the consumer, bearing in mind that the consumer is usually motivated by the impression gained from a brief scanning of the advertisement.

Other relevant sections from the ICC Code include:

> Article 2: Advertisements should be so framed as not to abuse the trust of the consumer or exploit his lack of experience or knowledge.
>
> Article 12: Advertisements should not without reason, justifiable on educational or social grounds, contain any visual presentation or any description of dangerous practices or of situations which show a disregard for safety . . .

The Code contains further special provisions for certain advertising practices and particular goods and services. For example:

> A. 1. Guarantees . . . Advertisements may contain the word guarantee . . . or words having the same meaning only if the full terms of the guarantee as well as the remedial action open to the purchaser are clearly set out in the advertisements, or are available to the purchaser in writing at the point of sale, or with the goods . . .
>
> B.9. Dangerous products: Advertisements for products which are potentially poisonous or flammable or otherwise dangerous but which may not be readily recognized as such by consumers should indicate the potential danger of such products.

The draft FAO Code (7th draft) also addresses advertising of pesticides and proposes that national governments ensure that those parties involved in the advertising of pesticides respect the following rules:

> 11.2.1: advertising does not encourage uses other than those specified on the approved label;
>
> 11.2.2: promotional material does not include use recommendations at variance with those of the recognized research and advisory agencies;
>
> 11.2.3: advertisements do not misuse research results or quotations from technical and scientific literature;
>
> 11.2.4: claims as to safety, including statements such as "safe", "non-poisonous", "harmless", "non-toxic", are not made, with or without a qualifying phrase such as "when used as directed";
>
> 11.2.5: statements comparing the safety of different products are not made;
>
> 11.2.6: misleading statements are not made concerning the effectiveness of the product;
>
> 11.2.7: any guarantee or implied guarantee e.g. more profits with . . ., guarantees high yields — are not given unless definite evidence to substantiate such claims is available;
>
> 11.2.8: advertisements do not contain any visual representation of potentially dangerous practices such as mixing or application without sufficient protective clothing: use near food; use by or near children;
>
> 11.2.9: advertising or promotional material includes the appropriate warning phrases and symbols as laid down in the labeling guidelines thus clearly indicating, prior to purchase, the potential danger of the product;
>
> 11.2.10: technical literature provides adequate information on correct practices including the observance of recommended rates and frequency of application and preharvest intervals;
>
> 11.2.11: all staff involved in sales promotion must be adequately trained and possess sufficient technical knowledge to present complete, accurate and valid information on the products sold;
>
> 11.2.12: farmers' organizations or workers' unions, as appropriate, are fully informed of the risks and hazards derivable from the use of pesticides for the information of their members.

These codes are infringed daily by companies who should know better, many of them members of ICC. Some of the potentially dangerous practices to be avoided in advertising include;

- Use of the word "safe"
- Listing guarantees
- Showing a person using pesticides in a dangerous manner
- Excluding warning phrases
- Encouraging excessive use

In conclusion, it is clear that many products available over the counter in Third World countries cannot realistically be used safely by often illiterate and poverty-stricken farmers even if the ads and labels are perfect. What is needed are controls which will prevent the availability of the most highly toxic products except in exceptional and strictly controlled circumstances. Labeling and advertising practices in the Third World today are grossly inadequate and in some cases dangerously misleading and irresponsible. It is clear that some strong standards must be set and enforced.

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DISCUSSION

Q. (J. Cosse), GIFAP: By way of comment, elaborated on how GIFAP has attempted to convince governments of developing countries to do something about their legislative machinery. He observed that the FAO code of conduct was voluntary and not a substitute for national legal effort. He informed the meeting that GIFAP opposed Chapter 7 of the Pesticide Code because it believes that it is the responsibility of national governments of importing countries to ask for any information and not of exporting countries.

A. (D. Bull), ELC, Nairobi: Advanced that deleting the two chapters did not take into consideration the fact that Third World countries do not have the means to carry out any technical analysis and have to rely for a large part on the exporting countries.

Q. (R. Neewoor), Mauritius: Observed that all the information could not fit on small containers and retail detail.

A. (D. Bull), ELC, Nairobi: Small quantities are most suitable for small farmers but only for less hazardous chemicals.

Q. (J. Compton), Mozambique: Observed that labels get torn during transportation — are there any good quality labels recommended?

A. (D. Bull), ELC, Nairobi: The FAO gives guidelines on labels and on symbols but more technical guidance is required.

Regulations of Pesticides in the United States

by
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In the United States, pesticides are regulated at both the federal and state levels. The basic controls are applied through the premarketing registration of pesticide products under the Federal Insecticide Fungicide and Rodenticide Act (FIFRA). Another federal law, the Federal Food, Drug and Cosmetic Act (FFDCA), provides for the establishment of residue clearances for pesticides used on food crops, feed crops, meat animals, dairy animals or in a way that is likely to leave residues on or in food. These clearances are required to support registration under the FIFRA when such uses appear on labeling. Both the registration under FIFRA and establishment of residue clearances under FFDCA are administered by the US Environmental Protection Agency (EPA). There are, however, provisions for state regulating agencies to issue registrations to meet special local needs and to issue emergency exemptions under special conditions.

FIFRA also provides for classifying pesticide uses as "Restricted Use" or "General Use", certification of pesticide applicators, experimental use permits, registration of pesticide producing establishments and several enforcement functions.

The registration of pesticide products under state laws in most cases, amounts to a licence to sell the product within the state and is based largely upon the federal registration. Some states have substantive regulatory requirements that may exceed federal requirements.

Most enforcement functions are carried out by state agencies under state laws or provisions of the FIFRA which have been delegated to the states. There is close cooperation between EPA and state agencies on enforcement matters.

REGISTRATION OF PESTICIDES

Premarketing registration is required under the FIFRA for all pesticide products sold within the U.S. or offered for export, except those formulated and packaged in accordance with the specifications of the foreign purchaser. Registration is not required for such exported products when the foreign purchaser has furnished written acknowledgement that he understands the product is not registered and cannot be legally sold in the U.S.

The procedure followed and the criteria applied in the registration process have been subject to continuous change in recent years. This includes several changes in the law, issuance of numerous regulations, guidelines and standards. Many pesticides previously registered for agricultural use have been cancelled or severely restricted in the scope of use.

To meet current requirements for registration, a proposed pesticide must be supported by extensive test data that will enable EPA to evaluate its usefulness and the risks involved. From such evaluations, the adequacy of proposed labeling can be determined.

General labeling and data requirements are set forth in EPA's regulations and guidelines. Appendix I outlines the data likely to be required. In addition, registration standards for specific pesticides list the requirements for each in detail.

Labeling requirements are adjusted to fit the pesticide formulation or product and some variation is involved. In general, labeling must be adequate, when followed, to provide for safe and proper use. This, includes directions for use, necessary warnings and cautions and necessary use restrictions. EPA's labeling requirements are set forth in regulations 40 CFR, Part 156, and are summarized in Appendix II.

Pesticides which are registered are subject to re-evaluation as new information becomes available. EPA has established extensive procedures for review and application of current requirements to previously registered pesticides in such cases. A schedule for completion of such re-evaluations has been adopted.

ESTABLISHMENT OF RESIDUE TOLERANCES

When pesticides are proposed for use in a manner that is likely to leave residues on food or feed, a residue tolerance or other clearance is required. A tolerance is the maximum level of residue which can legally remain on a food commodity when it is marketed. An Exemption from the Requirement of a Tolerance means that any level of residue resulting from the registered use of the pesticide would be legal.

A determination of Generally Recognized as Safe (GRAS) may be established for a substance when there is little or no concern over the safety of residues on food. Sulfur is an example.

The residue levels in crops are determined from supervized field trials, using various rates, numbers of applications, and intervals between last treatment and harvest. Safety is established through reproduction and long-term animal feeding studies, using various species of test animals. These toxicity studies determine the "No Observable Effect Level" (NOEL), which is the highest level at which the chemical shows no harmful effect on the most sensitive test animal.

By dividing this NOEL by a safety factor of up to 100 or more, an Acceptable Daily Intake (ADI), is set. The ADI is considered to be well within the amount of residue that can be ingested by an average person every day for a life time without adverse effects. The use of the safety factor means the legal residue is at a level far below that which has any adverse effect on the most sensitive test animal.

Tolerances are usually established to cover residues resulting from the use of a specific pesticide on a specific food commodity or group of commodities. They are set at minimum levels to cover the residues remaining from the pesticide use and well within safe limits. Tolerances legally apply to food commodities as they are marketed and do not necessarily reflect the level of residues remaining on food as it is eaten. This permits enforcement of tolerances in the market place where food shipments can be regulated and controlled.

In the establishment of tolerances, EPA assumes that all of the food commodity for which a tolerance is established will contain residues at the tolerance level. Seldom, if ever, would all of the acreage of a given crop be treated with the same pesticide and at maximum rates. Food basket surveys have shown that levels of residues on food are far below legal limits.

USE CLASSIFICATION

The FIFRA requires that EPA classify pesticides as "Restricted Use" or "General Use". Most farm chemicals and home garden products used for pest control are general use products. They can be used by anyone who can follow label directions. However, a few products, because of acute toxicity or other hazards, may require special care and attention to ensure that workers, the public, and the environment are protected from unacceptable exposure. These products may be classified for restricted use. Such products can be sold only for use by or under the supervision of a certified applicator.

CERTIFICATION OF APPLICATORS

The certification or licensing of pesticide applicators under the FIFRA is carried out through a joint federal-state effort. The actual certification is done by state agencies following EPA guidelines.

Certified applicators are growers or commercial applicators who participate in EPA-approved state training programs in agrochemical handling techniques and safety precautions, and pass a federally approved examination. More than half of America's farmers are certified applicators.

SUMMARY

A clear explanation of pesticide regulation in the U.S. from a manufacturer's point of view is given in a publication entitled, *Agricultural Chemicals: From Laboratory to Commercial Label*, prepared by the National Agricultural Chemicals Association.

The legal and administrative procedures followed in regulating pesticides in the U.S. are very complex and often result in lengthy delays. The number of people and organizations which participate in some major decisions is quite large and the process is very costly. They are, however, necessary for the safe and proper handling and use of modern pesticides which are an important part of agricultural production.

APPENDIX I

Data Requirement for Pesticide Registration in the US

Data requirements to support pesticide registration will vary dependent upon the proposed pattern of use, the chemical and toxicological nature of the pesticide and the likelihood of exposure by man, beneficial plants or animals or other sensitive segments of the environment.

The following is an outline of the types of data likely to be required to support registration and enable EPA to determine what labeling is necessary. More specific requirements for a particular pesticide will be delineated in a "registration standard."

Product Chemistr.

Extensive data on the chemistry of the active pesticidal ingredient and the formulated product is required.

The guidelines for product chemistry data requirements are set forth in "Pesticide Assessment Guidelines, Subdivision D, Product Chemistry", (40 CFR, 158. 130).

1. Tests that may be required:

Product identity

- Identity of ingredients
- Statement of composition
- Discussion of formation of ingredients

Analysis and certification

- Preliminary analysis
- Certification of limits
- Analytical methods for enforcement of limits

Physical and chemical characteristics

- Color
- Physical state
- Odor
- Melting point
- Boiling point
- Density, bulk density or specific gravity
- Solubility
- Vapor pressure
- Dissociation constant
- Octanol/water partition coefficient
- pH
- Stability

Test substances

- Pure active ingredient
- Technical grade of active ingredient

- Formulated product

Purpose for requirements

- To identify the ingredients and their relative percentages in the product for safety evaluation and labeling purposes

- To identify any chemical physical hazards for safety evaluation and determine appropriate labeling precautionary statements.

Residue chemistry

When the proposed use of a pesticide can reasonably be expected to result in residues in or on food or feed, tests must be conducted to show what level of residues remain and their identity. The guidelines for residue chemistry data requirements are set forth in "Pesticide Assessment Guidelines, Subdivision O), Residue Chemistry", (40 CFR, 158.125).

Tests that may be required

- Residue studies
  Include field plot studies involving the use of the pesticide as directed on label and collection of samples for chemical analysis

- Animal metabolism studies

- Plant metabolism studies

- Analytical method (for enforcement purposes)

Test substances

- The crop or commodity which has been treated with the pesticide in the manner proposed in labeling. This includes timing of application, dosage rates, preharvest intervals, or other restrictions on the use which will appear on the labeling. Exaggerated dosage levels may be required as well as untreated controls.

- Analysis is conducted to determine residues resulting from the application. This includes residues of the parent compound, metabolites or other breakdown products remaining on the crop or commodity.

- Plant and animal metabolism studies are often required to determine the fate of the pesticide residues within biological systems.

Purpose for requirements

- To determine the levels and identities of residues remaining on crops or commodities from the proposed use of the pesticide.

- To evaluate the potential hazards from exposure to the pesticide and the relative safety of the residue levels remaining on the crop or commodity.

Toxicology

Various laboratory studies with test animals are required for pesticides proposed for registrations. These are necessary to enable EPA to determine the risks involved and the restrictions and precautions that must be taken in handling and using the pesticide. In addition, long-term studies are needed to evaluate the risk from consumption of any residues that may remain on food from the use of the pesticide. The guidelines for such test requirements are set forth in "Pesticide Assessment Guidelines, Risk Assessment," (40 CFR, 158.135).

Toxicology data that may be required

- Acute toxicology studies

- Sub-chronic toxicology studies

- Chronic toxicology studies

- Mutagenicity studies

- Teratogenicity studies

- Oncogenicity studies

- Metabolism studies

Wildlife and aquatic organism data

Laboratory and/or field tests involving wildlife species are required if the proposed use of a pesticide would likely result in exposure of such species. The guidelines for wildlife and aquatic organism data requirements are shown in 40 CFR, 158.145.

Tests that may be required

Avian and mammalian testing

- Avian acute oral toxicity

- Avian sub-acute dietary toxicology

- Wild mammal toxicity

- Avian reproduction

- Simulated and actual field testing — mammals and birds.

Aquatic organism testing

- Acute freshwater fish toxicity

- Acute toxicity to freshwater invertebrates

- Acute toxicity to estuarine and marine organisms

- Fish early life stage and aquatic invertebrate life cycle

- Fish life cycle
- Aquatic organism accumulation
- Simulated or actual field testing aquatic organisms

Test substances

- Technical grade of active ingredient
- Typical end use product formulation for field studies only

Purpose for requirements

- To determine potential hazards to wildlife
- To measure risks to wildlife
- To label product to reduce risk

Plant protection data
Field studies required to enable EPA to evaluate potential damage to crops or other beneficial plants are set forth in (40 CFR, 158.150).

Tests that may be required

Tier I

- Seed germination/seedling emergence
- Vegetative vigor
- Aquatic plant growth

Tier II

- Terrestrial field studies
- Aquatic field studies

Test substances

- Technical grade of the active ingredient
- Typical end-use product formulation for field studies only
- Specific end-use product formulations for photo-toxicity studies only

Purpose for requirements

- To determine hazards to target and non-target plants
- To determine risk to endangered species
- To develop appropriate precautionary labeling

Non-target insect data requirements
Studies needed to enable EPA to evaluate the potential risks to beneficial non-target insects are set forth in (40 CFR, 158.155).

Tests that may be required

- Honeybee acute contact toxicity
- Wild bee toxicity of residues on foliage (+) alfalfa
- Honeybee sub-acute feeding study
- Field testing for pollinator
- Acute toxicity to aquatic insects
- Acute insect life cycle study
- Field study for aquatic insects
- Predatory/parasite insect testing

Test substances

- Typical end-use product formulations
- Technical grade of the active ingredient for the honeybee acute contact toxicity only

Purpose for requirements

- To determine hazards and risks to beneficial insects
- To develop proper precautionary labeling to protect beneficial insects

Re-entry protection data requirements
Studies needed to enable EPA to evaluate the potential risks to workers entering treated fields and establish re-entry intervals are set forth in (40 CFR, 158.140).

Tests that may be required

- Foliar dissipation
- Soil dissipation
- Dermal exposure
- Inhalation exposure

Test substance

- Typical end-use product formulation

Purpose for requirements

- To determine risks to farm workers and others who may be exposed

- To determine duration of hazard potential
- To develop precautionary labeling including re-entry intervals and protective clothing directions

Environmental fate data requirements
Studies needed to enable EPA to determine risks to the environment and set appropriate limitations and restrictions are set forth in (40 CFR, 158.130).

Tests that may be required

Degradation studies — lab

- Hydrolysis
- Photodegradation
- In water
- On soil
- In air

Metabolism studies — lab

- Aerobic soil
- Aerobic soil
- Anaerobic soil
- Anaerobic aquatic
- Aerobic aquatic

Mobility studies

- Leading and adsorption/desorption
- Volatility (lab)
- Volatility (field)

Accumulation studies

- Rotational crops (confined)
- Rotational crops (field)
- Irrigated crops
- In fish
- In aquatic non-target organisms

Dissipation studies field

- Soil
- Aquatic (sediment)
- Forestry
- Combination and tank mixes
- Soil, long-term

Test substances

- Technical grade of the active ingredient or pure active ingredient radiolabeled
- Typical end-use product formulation

Purpose and requirements

- To determine the potential of a pesticide to contaminate ground water
- To determine the fate of the active ingredient and significant metabolites in the air, soil and water
- To determine the ingredient's persistence
- To develop appropriate labeling, including precautionary statements, geographical restrictions and disposal guidance

The above outline of data requirements refer to conventional chemical pesticides. Data requirements for biorational, biochemical or biological organisms proposed for use as pesticides are very similar. These are, however, required in a tiered or incremental fashion and some of the requirements may be waived if warranted by initial test data and are set forth in 40 CFR 158.165.

APPENDIX II

Pesticide labeling requirements in the US
The Environmental Protection Agency has established numerous labeling requirements which are specific to the various types of pesticides. However, the general requirements for all labeling are summarized below. In addition, a standard label format is included.

LABELING REQUIREMENTS OF THE FIFRA

Label Element	When Required	Placement on Label		Comments
		Required	Preferred	
Product name	All products	Front panel	Center front panel	
Company name and address	All products	None	Botton front panel or end of label text	If registrant is not the producer, must be qualified by "Packed for . . .", "Distributed by . . .", etc.
Net contents	All products	None	Botton front panel or end of label text	May be in metric units in addition to US units
EPA Est. No.	All products	None	Front panel	Must be in similar type size and run parallel to other type
EPA Reg. No.	All products	None	Front panel, immediately before or following Reg. No	May appear on the container instead of the label
Ingredients statement	All products	Front panel	Immediately following product name	Text must run parallel with other text on the panel
Pounds gallon statement	Liquid products where dosage given as lbs. at unit area	Front panel	Direct below the main ingredients statement	
Front panel precautionary statements	All products	Front panel		All front panel precautionary statements must be grouped together, preferably blocked
Keep Out of Reach of Children (child hazard warning)	All products	Front panel	Above signal word	Note type size requirements
Signal word	All products	Front panel	Immediately below child hazard warning	Note type size requirements
Physical or chemical hazards	All pressurized products, others with flash points under 150°F	None	Same as above	
Restricted use statement	All restricted products	Top center of front panel	Preferably blocked	Includes a statement of the terms of restriction. The words "RESTRICTED USE PESTICIDE" must be same type size as signal word.
Misuse statement	All products	Immediately following statement of classification or ahead of directions for use		

Label Element	When required	Placement on Label		Comments
		Required	Preferred	
Re-entry statement	All chlorinesterase inhibitors	In the directions for use	Immediately after misuse statement	
Storage and disposal statements	All products	In the directions for use	Immediately before specific directions for use or at the end of directions for use	Must be set apart and clearly distinguishable from other directions for use
Directions for use	All products	None	None	May be in metric as well as US units
Skull & crossbones and words POISON (in red)	All products which are Category based on oral. I based on oral. inhalation toxicity	Front panel	Both in close proximity to signal word	
Statement of practical treatment	All products in Categories I, II, and III	Category I front panel unless referral statement is used. Others: Grouped with side panel precautionary statements	Front panel for all	
Referral statement	All products where precautionary labeling appears on other than front panel	Front panel		
Side back panel precautionary statements	All products	None	Top or side of back panel preceding directions for use	Must be grouped under the headings in 8A, 8B, and 8C; preferably blocked
Hazards to humans and domestic animals	All products in Categories I, II and III	None	Same as above	Must be preceded by appropriate signal word
Environmental hazards	All products	None	Same as above	Environmental hazards include bee caution where applicable

DISCUSSION

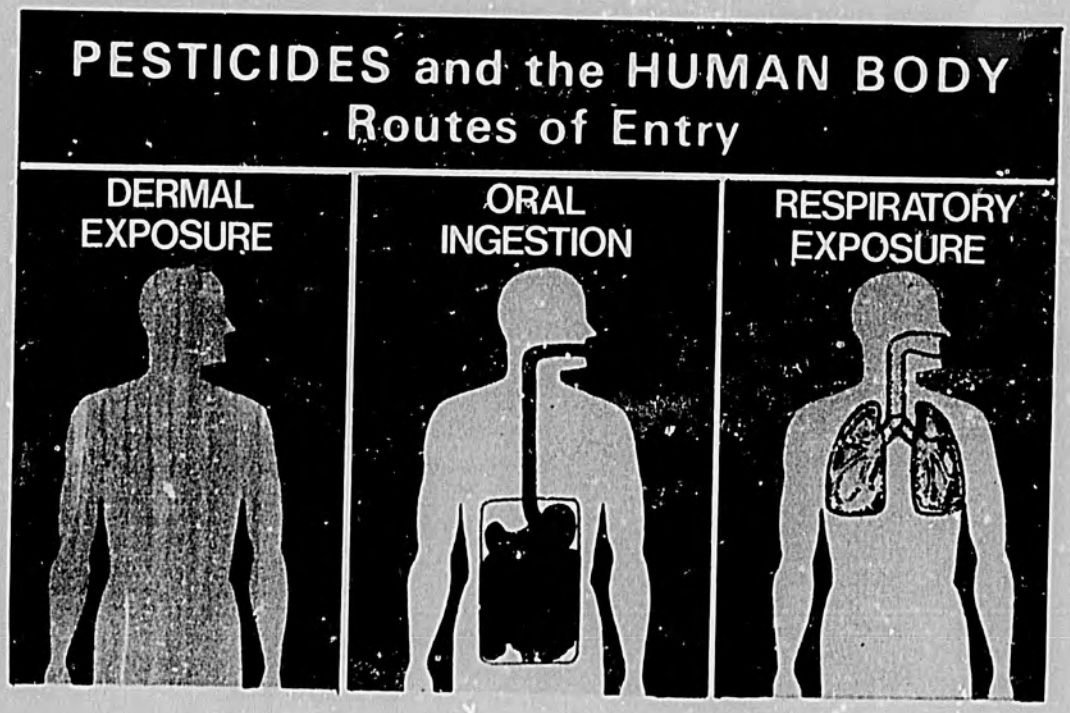
Q. (Janice Jensen), AID, Lusaka: Inquired from the speaker whether the market-based survey referred to in the paper was operative.

A. (H. Alford): EPA takes samples from materials on market and carries out analysis and publishes recommendations.

Q. (Mr. S. Goma), Zambia: Requested the speaker to comment on the reviewable pesticide scheme referred to in the paper.

A. (H. Alford): The scheme has been operative since 1975 and some action has taken place which includes cancellation of registration of some chemicals, or putting some under restricted use.

V.
Health and Environmental Concerns in Pesticide Management



COUNTRY PAPER

A.O.K. Obel — Pesticide poisoning in Kenya and other ESA countries

TOPICAL PAPERS

J.E. Davies — Toxicology and human health considerations in pesticide use. Do subsistence farmers in ESA know enough to protect themselves?

J.E. Davies — The agromedical approach — Can it work where there are no doctors?

H.G. Alford — Classification, chemistry and toxicology of pesticides

Pesticide Poisoning in Kenya and other ESA Countries

by
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INTRODUCTION

The problem of pesticide poisoning in Kenya continues to cause grave concern to those of us in the medical field and no doubt to other groups of informed opinion. The following story which appeared in a Kenyan daily in 1985 illustrates the point:

> A prominent Machakos businessman, Mr. Joseph Mutiso Ndolo, has been found dead in his shop building.
>
> His body was discovered in a room next to a bottle of soda and gamatox, an insecticide used against animal ticks.
>
> Mr. Ndolo had disappeared from public view for two days. His younger brother recently sustained panga and axe wounds after being attacked by thugs and is recovering at Machakos hospital.
>
> Police and assistant chief Julius Musyoka of the area had to break into the room at Miswakani market to remove the body.
>
> Mr. Ndolo had shifted his family and belongings, including cattle, household goods and shop ware to the home of his in-laws.
>
> He had also sent them a note which said: *"Kwaheri na mubaki salama"*. The note is now with the police.

This type of report is only the tip to the iceberg. Sceptics may well say that those who are bent on taking their own lives will do so irrespective of the presence or absence of pesticides. Many of us in medicine do not share that view. The availability of the means and the high chances of succeeding greatly abet the occurrence of such incidents. Although we cannot delve deeply into suicide as an aspect of forensic psychiatry we cannot afford to ignore the fact that reducing the chances of acquiring pesticides, particularly the highly toxic forms, may well reduce the incidence and prevalence of pesticide poisoning and the mortality and morbidity associated with it. In such considerations we are not necessarily party to the moral implications of suicidal tendencies. We are mainly interested in preventing their occurrence and minimizing the chances of success of suicidal attempts.

We, in medicine, are however not blind to the fact that Kenya and other Eastern and Southern Africa countries have economies which are predominantly agriculture-based. We therefore cannot discourage the use of pesticides, as such an approach could well be counter-productive. Indeed, in very recent times, Kenya and Tanzania, among other Eastern and Southern African countries, were nearly ravaged by armyworms had it not been for the timely availability of pesticides. Thus pesticides have a significant and beneficial role to play in maintaining the right balance in the agro-ecosystem, and probably more important, in sustaining the economies and hence political stability of countries which depend predominantly on agricultural output. We, in agriculture-dependent countries, nevertheless, would do well to restrict the use and availability of these dangerous and lethal compounds. This is to the advantage of not only the consumers but also of the manufacturers. Manufacturers benefit because the development of resistance to pesticides is less likely with controlled use of pesticides enabling them to produce the same compounds at a reasonable cost. Restricted availability of toxic pesticides lessens the chances of accidental or deliberate exposure.

MAGNITUDE OF PESTICIDE POISONING IN KENYA

A look at the case report forms of the emergency units of hospitals in Kenya shows that pesticide poisoning is a frequent cause of admission in many of these hospitals. Most of the cases admitted under such circumstances are secondary to acute exposure to pesticides. Exposure leads to a variety of symptoms which deteriorate very rapidly leading to coma and death within 24 to 48 hours unless there is swift and appropriate intervention. This rapid action seems to encouage the use of pesticides in suicide attempts.

A less dramatic case is that of the occupationally exposed agricultural farm workers. These people are at an increased risk of developing long-term adverse effects. They usually give non-specific complaints such as general malaise or asthenia. Safety guidelines given by the manufacturers are particularly important for these people. Unfortunately hot weather conditions do not always permit adherence to the guidelines and sometimes they are carelessly flouted. This could be because of the low standard of education of many farm workers who are generally unaware of the risks involved in the use of pesticides. This is particularly true of labor-intensive large plantations which rely very heavily on semi-skilled or unskilled workers.

The third level of exposure is the chronic low exposure or incidental exposures of the general public. This is often in the form of pesticide residues polluting the environment contamination of water supplies not only adversely affects marine biology; it may also induce conditions favourable for the development of

*Daily Nation, Thursday, March 7, 1985

various forms of cancer and other diseases in man as well as other animals which are dependent on the polluted environment for their very survival. Pesticides which are strongly adsorbed in soil, such as the chlorotriazine herbicides, are known to have a rather long lasting effect. Agents which have a high leaching index are fairly rapidly eluted and may pose danger to marine agroecosystem which may, in turn, affect man directly or indirectly.

PESTICIDES COMMONLY IMPLICATED IN POISONING IN KENYA

Pesticides used in Kenya include insecticides, acaricides, herbicides, fungicides and nematicides. Some pesticides may have more than one role. For instance MIRAL or ISAZOFOS has broad spectrum activity against nematodes which infest the roots of plants and a good efficacy in the control of soil insects. Thus as a nematicide, MIRAL controls endo, semi-endo, and ectoparasites while as an insecticide it is recommended for use against Coleoptera, Diptera, Heteroptera, Homoptera, Lepidoptera and Hymenoptera. Hence a rigid classification of pesticides is probably not of much value. It is therefore probably more useful to consider compounds on an individual basis.

The pesticides which are commonly associated with acute exposure in suicide in Kenya include GAMATOX, an acaricide, as in the example cited above, and DIAZINON, an insecticide of the organophosphate group GAMATOX poisoning is not common in urban areas but much more frequent in rural areas where tick-borne diseases are a constant threat to the livestock industry. DIAZINON and related organophosphate poisoning, on the other hand, is extremely common in urban areas. ISAZOFOS or MIRAL is another example of an organophosphate insecticide which is basically applied as a systematic soil nematicide. BAYGON which is an organophosphate compound containing PROPOXUR is a widely available insecticide in the form of emulsifiable concentrate and is basically a household product which is commonly amenable to abuse in either suicide or attempted suicide-resulting in high mortality. These are avoidable risks which could be mitigated by restricting the availability of these toxic agents. These and related agents are, after all, much more toxic than some stringently controlled pharmaceutical products.

Pyrethroids such as KILLTOX are widely available in Kenya as sprayable insecticides and are much less dangerous than the organophosphorus compounds.

PARAQUAT is a commonly used but dangerous weed killer. This herbicide is chemically a dipyridilium. It is very toxic in the concentrated liquid form as supplied to farmers and horticulturists. Its poisoning is associated with high mortality in spite of its unique property of being inactivated by contact with soil. It is available in Kenya as GRAMOXONE.

APPROACH TO PESTICIDE POISONING

Many fatalities through pesticide poisoning happen either because they have been intentionally concealed or because of delays before medical intervention. Many of these cases are encountered in an emergency situation following acute exposure; and the nature of the poisoning is usually not known either because of fear of the legal implications for the victim or because the next of kin are genuinely uncertain of the poison that might have been involved. The tendency to decant pesticides into soft drink or wine bottles makes the identification of the pesticide involved in a given case very difficult in a clinical setting.

CONCLUSION

Pesticide poisoning is a serious problem in Kenya in respect of its magnitude and outcome. Measures should be taken to increase public awareness of the dangers of these compounds. Further steps should be adopted to restrict the availability of pesticides just as is the case with pharmaceutical products. Pesticide manufacturers should be encouraged to give full and accurate statements on the safety of their products. Highly toxic pesticides should only be used under close supervision by individuals who either have some training in toxicology or are conversant with the hazards of these compounds. The use of such pesticides as household items should be curbed. It is to be hoped that greater attention will be paid to the use of alternative methods of pest control such as the sterilization of insects which is currently largely a research activity but whose potential is tremendous. Other forms of integrated pest management such as the application of control by varietal resistance, manipulation of insect behavior and biological control should also be seriously considered with a view to their adoption and implementation.

However, pesticides will continue to play a significant role in pest management for a long time to come, not only in Kenya and other Eastern and Southern African countries, but throughout the world.

GENERAL DISCUSSIONS ON THE PAPERS

Dr. R. Neewoor of Mauritius asked Dr. Obel whether he had any statistics on the mortality and morbidity with regard to pesticide poisoning. It was answered that Kenyatta Hospital, Aga Khan and a third hospital in Nairobi have the following statistics.

: Kenyatta 1-2 cases of actual pesticide poisoning daily
: Aga Khan 2 cases of confirmed cases weekly
: 1 case weekly at the third Nairobi hospital. Usually organo-phosphates are the suspected poisons.

Question on whether Dr. Obel's department was involved in registration was asked by Mr. Cosse of GIFAP. It was answered that the Director of Vector-Borne Diseases of Ministry of Health was a member of the Pesticide Board of Kenya. Mr. Kibata of Kenya, commented that there was very little information on poisons responsible for illness. He however said that diazone and paraquat were among these.

Mrs. Odipo of Kenya asked why during their field assessment the department of environment found that there were a lot of miscarriages among women in rural farming areas and wondered if this was due to pesticides. Dr. Obel and Mr. Alford indicated that in some studies done elsewhere, pesticides have been implicated.

Toxicologic and Human Health Considerations of Pesticide Use

(Do Subsistence Farmers in Eastern and Southern Africa Know Enough to Protect Themselves?)

by
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USA

I shall attempt to review these issues of toxicology and human health considerations in pesticide use and the agromedical approach by first presenting an overview of the toxicologic and health problems connected with modern pesticide use practices. Subsequently I will propose an agromedical approach to pesticide management, which we from the Consortium of International Crop Protection have long advocated as being one of the answers to the problems posed by the chemical pesticide strategy. The two presentations, therefore, are closely related and hopefully, will answer the thought-provoking secondary questions of the possible hazards to the subsistence farmers in this region, and the potential of the agromedical approach in filling in some of the gaps in remote areas where doctors are not readily available.

Because only an overview will be possible within these time frames, I would like to suggest that those who have an interest in the health prospect of pesticide management might want to obtain more information from the accompanying manuscript entitled "An Agromedical Approach to Pesticide Management", copies of which are available. Some chapters which more fully address the topics touched upon in this presentation include: Who Gets Poisoned and Why? The Epidemiology of Pesticides, Clinical and Toxicological Aspects of Pesticides, First Aid, and Pesticide Monitoring.

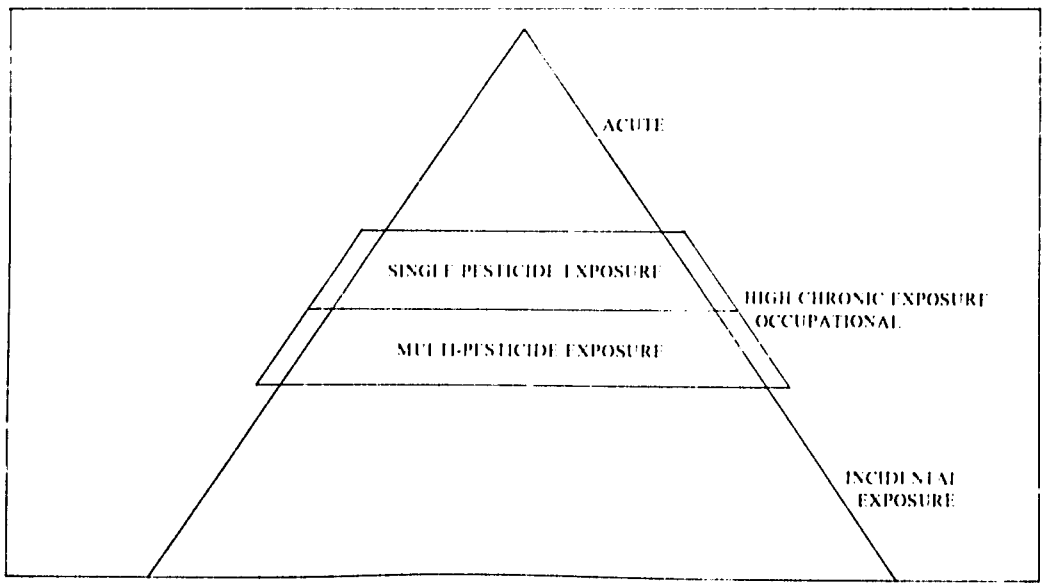
GENERAL TOXICOLOGY AND HUMAN HEALTH CONSIDERATION

These will be reviewed in accordance with the exposure categories shown in Figure 1.

The aforementioned classification of human pesticide exposure permits evaluation of potential adverse health effects in a population on the basis of: descriptive and toxicological features of clinical poisoning; the epidemiological study of the occupationally exposed (having as the goal of such studies the investigation into those adverse health effects which are the result of chronic, long-term exposure to individual and multiple mixtures of pesticides and or their solvents; and the investigation of incidental human exposure to pesticides an the etiology of the pesticide "pollutogram".

The term "pollutogram" is selected in preference to body burdens for it describes external pollution of environmental chemicals, particularly pesticides, that can be found in adipose tissue, serum, and mother's

FIGURE 1
CATEGORIES OF EXPOSURE



milk as well as the urine. Such studies embrace the sources of magnitude of exposure from the persistent lipophilic organochlorine pesticides, and the aklyl phosphate and phenolic urinary metabolite profile that may be sustained as a result of incidental exposure to organophosphate and carbamate insecticides. In contrast to the lipophilic organochlorine pesticide body burdens, the latter urinary metabolites are reflective of a short-term exposure to the aforementioned group of insecticides.

Population at risk

It is important to understand which groups of people are at risk from pesticide poisonings, as a result of modern pesticide usage practices. Obviously, the occupationally exposed person is at special risk for he or she will fit somewhere into the pesticide chain of production (see Figure 2).

This extends from the site of manufacture through formulation and transport to the farmer. Here the farmer or his applicator, who may be using a spray ring, a backpack, or maybe a helicopter or fixed wing aircraft pesticide applicator, will be exposed during the application process. He/she or their assistants will also be at risk of serious exposure during the mixing and dilution of the pesticide concentrate before it is applied.

Once the compound has been applied exposure may be sustained by people in the field. These include: cotton scouts, who may be in the fields ascertaining the economic thresholds of pesticides being sprayed on crops in an integrated pesticide management program, or the pickers and harvesters who have gone into the field too soon after application (picker poisoning).

Apart from the occupation category, pesticide poisonings are also problematic in the home setting where, of course, the child is at special risk.

In addition to systemic poisoning, toxicology effects may be localized to specific end organs where the exposure has been topical. These are primarily found in skin and the eyes where a variety of lesions may occur in either organ.

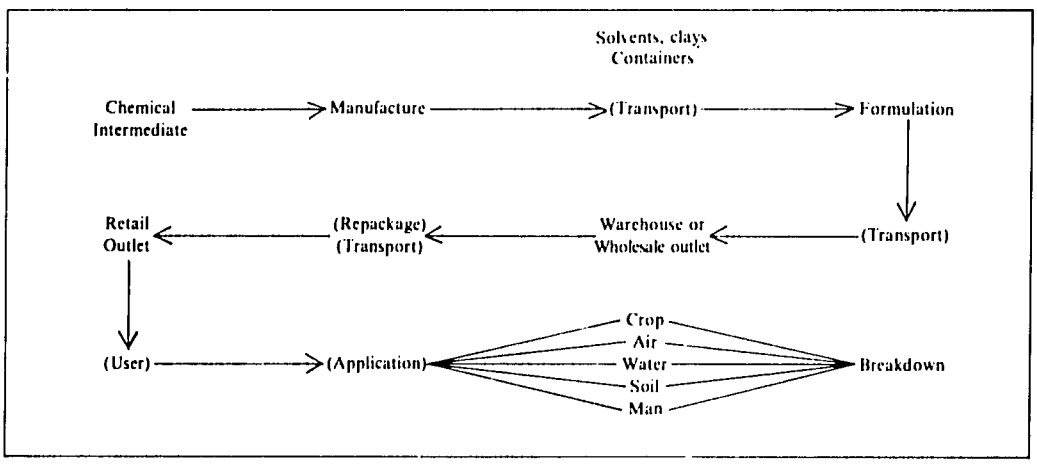
In many parts of the world besides human poisoning, consideration must be given to animal poisoning a' ', because serious economic loss can occur if agricultural livestock are actually poisoned by pesticides.

Since 1945 some 1,500 individual compounds have come into use as pesticides and these chemicals have been offered for sale and application in about 35,000 to 40,000 different formulations. However, only about 150 of these chemicals are widely used.

HAZARDS OF PESTICIDE USE

The hazard of a pesticide — its potential for producing injury — depends on: the inherent toxicity of the active ingredients; the dose and/or concentration of the pesticide; the physical and chemical properties of the material; the route of absorption of the chemical; and the duration of exposure.

FIGURE 2.
PESTICIDE CHAIN FROM MANUFACTURE THROUGH USER



The dose (amount) of pesticide taken into the body is the most important factor in determining the hazard of a chemical. A small amount of some pesticides may cause severe illness; large doses of another may be fairly harmless. Pesticide concentrates are the most hazardous form. Persons working with them are at the greatest risk of getting a harmful dose.

The physical and chemical properties of some pesticides make them more hazardous in certain situations. Parathion, for example, changes to a more toxic chemical (paraoxon) at high temperatures.

The three possible routes of absorption are: ingestion — the result of accidents or suicide or homicide; inhalation occurring mainly in confined spaces (warehouses, pesticide tanks) usually causes less serious effects than ingestion; and dermal absorption, the most common method of occupational exposure.

The duration of exposure is another factor determining the dose absorbed. Brief exposure to a concentrate could produce effects similar to longer exposure to the dilute pesticide.

OCCUPATIONAL EXPOSURE TO PESTICIDE

Health effects of chronic long-term exposure to pesticides are a second area of general public concern. The area is certainly in need of expanded research, because doubt still exists as to the safety of long-term exposure.

Numerous epidemiologic studies have been conducted in the occupationally exposed, and chronic adverse health effects have been noted chiefly during the process of manufacture of single groups of pesticides. Such entities as neurogical and neurobehavioral disease were also observed during the formulation and excessive exposure sustained during the manufacture of Kepone® in Hopewell, Virginia. Many workers demonstrated opsoclonus, a finding which was correlated with blood Kepone® levels.

Another example where a specific adverse health effect was noted occurred during the manufacture and formulation of a flat soluble organophosphate-leptophos, an insecticide which had earlier been noted to cause hind-quarter paralysis in buffalo in Egypt. In the United States neurologic disease was identified in a Velsicol plant manufacturing leptophos in Houston, Texas, where several workers sustained chronic neurologic disease somewhat resembling multiple sclerosis.

Reproductive adverse health effects have been found during the application of dibromochloropropane. Male sterility was recognized as a result of occupational exposure to this fumigant. This adverse health effect resulted in its cancellation in the United States and subsequent follow-up of the exposed workers has suggested that the testicular effects were reversible.

Cancer risks

Mabuchi and his colleagues carried out an epidemiologic study wherein they demonstrated an association between occupational exposure to inorganic arsenic and lung cancer. This evidence was particularly impressive since there was a suggestion of a dose effect. The relationship of pesticides to cancer is the subject of continuing research, controversy and concern. Many of the pesticides which have been widely used in the past, have been shown to be carcinogenic on the basis of animal testing and/or short term in vitro mutagenicity testing. In the United States, several pesticides have either been cancelled or severely restricted because of an oncogenic trigger. Toxicologic data rather than epidemiologic has usually provided the evidence for the cancer trigger.

It is always difficult to extrapolate cancer risks from mice or rodents to man and good epidemiologic data, is more convincing because the risk in humans is measured. However, epidemiologic studies of pesticides for cancer risks are complicated by shortcomings in human exposure data, the multiplicity of pesticide exposures, changes in pesticide-use patterns, a rapid turnover of employees and the latency of cancer.

In spite of these difficulties, however, in the last decade, a sizable body of epidemiologic data has appeared in the medical literature which is beginning to contribute to a better understanding of the carcinogenic risk of these chemicals. Most have been conducted in the occupationally exposed and clues have been provided in case reports, cross-sectional studies, case-control and cohort studies.

Epidemiological studies of insecticides — Retrospective cohort studies

In 1979, Wang and MacMahon pointed out that although there had been several clinical studies of workers occupationally exposed to insecticides, these were generally based on small numbers, and had involved clinical and laboratory examinations. They commented on the fact that essentially no data could be found on the long-term mortality of exposed workers other than their study of workers during the manufacturing of chlordane and heptachlor.

The study was a cohort study of 1,403 white male workers employed in the manufacture of chlordane and heptachlor who had worked for more than three months during the period of 1946-1976. They found no overall excess deaths from cancer even in workers who had worked for 20 years or more. The 12 lung cancer deaths observed exceeded the nine cases expected but the difference was not significant.

Epidemiologic studies of herbicides

Case-reports: The first indication that occupational exposure to phenoxy acid herbicides might be associated with an increased risk of soft tissue sarcoma was described by Hardell in 1977. He discovered that five of seven patients with malignant mesenchymal tumors were forestry workers with confirmed exposure to phenoxy acids. The remaining two were indirectly exposed to these compounds because their work involved clearing phenoxy acid treated areas. Soft tissue sarcoma was not the only type of malignancy identified in Swedish workers with herbicide exposure. In 1979, Hardell described a histologically confirmed malignant lymphona in a patient who had an immense exposure to phenoxyacetic acid. In a pilot trial, Hardell and Sandstrom (1979) reported that 14 of 17 lymphoma patients acknowledged exposure to phenoxyacetic acids and chlorophenols.

Case control studies: Hardell's case reports (1977, 1981) suggesting an unexpectedly high frequency of mesenchymal tumors in persons occupationally exposed to phenoxyacetic acid herbicides prompted a case-control study of soft tissue sarcoma in forestry workers exposed to phenoxy acids and herbicides (Hardell and Sandstrom, 1978; 1979). The relative risk of exposure to both phenoxy acid and chlorophenols was 5.7 (97% confidence interval 2.9-11.3) and chlorophenols alone 6.6 (95% c.i. not stated). Only two patients and two controls had been exposed to herbicides not containing TCDD's so that the observed Relative Risks obtained for chlorophenoxy acids and chlorophenols and 2,4,5-T contain chlorinated dibenzodioxins as an impurity.

Eriksson, *et al.* (1981) conducted a similar case control study in southern Sweden; 110 men aged 27-75, diagnosed as having soft tissue sarcomas between 1974-1978 were matched with two controls per case. The soft tissue sarcomas included 33 leiomyosarcomas,

19 malignant fibrous histiocytomas, 15 liposarcomas and 9 neurogenic sarcomas.

Very similar risk factors were obtained from this study of herbicide exposed workers from South Sweden. The relative risk from both types of herbicides was 5.1 (95% c.i. 2.5-10.4). The authors concluded that exposure to phenoxy acid may be a contributory factor in the development of soft tissue sarcoma and that the risk is not limited to phenoxy acids that may contain chlorinated dibenzodioxins and chlorinated dibenzofurans for the relative risk for exposure to non-dioxin containing herbicides was 4.2 (95% c.i. 1.3-14.5).

Later in 1981, Hardell *et al*, found increased risks of malignant lymphoma in workers exposed to the phenoxyacetic acid and chlorophenol herbicides.

Conclusions

In this review of the epidemiology of pesticides, we have looked at some of the chronic effects which have been documented. Evidence suggests that a variety of different diseases might be associated with long-term occupational exposure to pesticides. With the exception of inorganic arsenic insecticides, the data are presently insufficient for the evaluation of the carcinogenic risk of insecticides.

With regard to herbicides, several studies of railroad, forestry and agricultural workers in Sweden provided limited evidence of a carcinogenic risk from occupational exposure to the phenoxyacetic acids and chlorophenol herbicides and TCDD. Soft tissue sarcomas and malignant lymphomas are two types of cancer in urgent need of further epidemiologic studies.

Coggon and Acheson (1982) have recently reviewed the question of whether phenoxy herbicides cause cancer in man, and conclude that further research is urgently needed to confirm or refute the associations both positive and negative which have been demonstrated in the Scandinavian case control studies and observations among workers employed in the manufacturing of these products in the United States.

In the meantime, the lesson for agromedicine from these epidemiologic studies is clear. The total picture is still not generally known and is still unfolding. In these circumstances no one will question the fact that any excessive exposure is unwarranted, and good agromedical practices should strive to minimize exposure.

INCIDENTAL EXPOSURE TO PESTICIDES AND ASSOCIATED HUMAN MONITORING PROGRAMS OF BODY BURDENS

The third level of pesticide exposure is the result of contact with trace amounts of different types of pesticides in our every day environment. These traces are contained in food, water, air, house dust, clothing, and a variety of other materials. Food is thought to be the main route to exposure, but for certain pesticides, domestic exposure from residues in house dust is also important

The concept of total body burden of pesticides was first introduced shortly after the occurrence of widespread human exposure to DDT, which followed its use in World War II. Shortly after the recognition, of DDT in fat, mother's milk, blood and serum, a whole host of other fat soluble organochlorine pesticides were identified. These were later followed by the recognition of other pesticides and or their metabolites, reflective of incidental exposure to the less persistent pesticides, such as the carbamates and organophosphate insecticides. Metabolites of these compounds were readily detected in the urine of the exposed individual and the U.S. general population. Since the octanol H_2O partition coefficient of most of the members of this group was relatively low, exposure to these pesticides was manifested by the excretion of metabolites in the urine for only 24 to 48 hours following exposure. In contrast, therefore, to the lipholic pesticides the urinary metabolites were usually indicative of recent exposure only and were, therefore, of limited epidemiologic value as biological instruments of long-term exposure.

As analytical methods have developed, over the years, the variety of chemicals which can be identified in the tissue of an average person, living in our industrial society, has grown enormously. Fat soluble lipophilic fluid, vernic caseosa, and, in fact, in almost every tissue of the human body. Similarly, alkyl-phosphate and phenolic insecticides are readily detected in the average U.S. citizen. This veritable "pollutogram" has not been shown to provide evidence of disease, being rather a measure of the small exposures that are ubiquitous in our modern environment. In spite of this, however, their recognition in the U.S. general population was one factor which in part contributed toward their ultimate cancellation.

Function of pesticide residue data in humans

As has been mentioned, the human "pollutogram" is really only a measure of incidental exposure, and this was the initial goal of international pesticide residue studies. Once it became apparent that there were several lipophilic pesticides which were readily detectable in adipose tissue of the different populations, several countries conducted small general population residue surveys. For the most part these were case series studies commenting on adipose concentrations of different pesticides in the groups studied in different countries. They were, therefore, not statistically representative of the entire national population, but their identification provided initial qualitative information on body burdens within the countries, permitting international comparisons.

United States adipose levels

In the United States, lipophilic pesticides and several other chemically related compounds such as PCB's and PBB's, and PCT's have been identified in most surveys. Table I shows fat soluble pesticides identified in 1975 and the frequencies, based upon analysis of 566 samples.

TABLE I
UNITED STATES ORGANOCHLORINE RESIDUES IN ADIPOSE TISSUE

Chemical	% Positive	Concentration in ppm, lipid basis Estimated geometric mean
Total DDT equivalent	100	5.16
Hexachlorobenzene	91	0.05
alpha BHC	1	0
beta BHC	97	0.26
gamma BHC	1	0
dieldrin	95	0.17
oxychlordane	96	0.14
trans-Nonochlor	96	0.14

PBC's were identified in 94% of samples
Source: Adapted from F.W. Kutz, 1976 Human Monitoring Program.

SEROLOGIC AND URINARY MONITORING DATA IN THE UNITED STATES

1. Sera

Serological monitoring surveys in addition to adipose data have also been ongoing in the United States, until 1982 when they were stopped for financial reasons. Under the Toxic Substance Control Act (TSCA), and the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended, the U.S. Environmental Protection Agency (EPA) is mandated to collect data on the exposure of humans and the environment to pesticides and other toxic substances. In partial fulfillment of these mandates, EPA participated in the Second Health and Nutrition Examination Survey (HANES II) conducted by the National Center for Health Statistics of the U.S. Public Health Service.

This national survey conducted between 1976-1980, was an evaluation of the health and nutritional status of the U.S. population. Personal interviews and physical examinations were given to a sample of the U.S. population drawn from 64 collection sites statistically distributed across continental United States. During the physical examination, blood serum and urine specimens were collected for the EPA. These specimens were then analyzed for selected residues of pesticides, other toxic chemicals and their metabolites. This program is also currently on hold.

Health Effects

Apart from liver microsomal enzyme induction and hyperlipidema with triglyceridema, adverse health effects from incidental exposure have not been unequivocally demonstrated. A 57% increase excretion of urinary hydrocortisol was demonstrated in 18 persons with a 5 year history of work exposure in a DDT manufacturing plant. Serum Phynyl-Butazone half life was reduced by 19% when compared to 18 matched controls. Drug and pesticide interactions have also been demonstrated by Kolmodin, who showed increased metabolism of antipyrene under conditions of occupational exposure to a variety of organochlorine pesticides (lindane, DDT and chlordane). The whole problem of drug and pesticide interactions is currently under intensive investigation and the pharmacoclinical consequences of liver enzyme induction is just beginning to be observed.

Apart from drug interactions, several studies of individuals with appreciable years of occupational exposure to insecticides have failed to reveal serious disease under these conditions. The health profile of workers occupationally exposed to DDT, measured by both biochemical and physical surveys, was particularly reassuring with regard to the safety of these exposures. Similar data for persons occupationally exposed to aldrin, dieldrin, telodrin and endrin have been reported by Jager. The results of these intensive occupational studies are particularly reassuring as to possible occupational health hazard of these pesticide industries.

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The Agromedical Approach — Can it Work Where There are No Doctors?

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INTRODUCTION

Earlier review of our knowledge of adverse effects of pesticides on human health has produced data which show that very carefully-controlled and continuously monitored pesticide management strategies are imperative at all three levels of exposure.

At acute exposure levels, there are obvious serious poisoning problems which are the result of both misuse and accidental use or the result of suicide.

Our review of the adverse health effects of chronic occupational exposure, highlights a variety of illnesses associated with such exposure, ranging from chlorance, male sterility, neurologic and neuro-behavioral disorders to cancer from inorganic arsenic. Furthermore, as one looks at the data, it is indicated clearly a lot is still unknown with regard to this type of chronic exposure, especially when such exposures are mixed.

When we look at body burdens, another biological index of incidental pesticide exposure, we must conclude that there is very little monitoring data being done. The picture is continuously changing, which reflects, on the one hand, good agricultural practices, but on the other can be diagnostic of grossly undesirable agricultural pesticide practices. Very little use has been made of the potential of human monitoring to detect unacceptable agricultural practices and undesirable human pollution.

In addition to the three direct areas of concern, pesticide management surveys of the tropics have suggested that agricultural use of pesticides has interfered with public health ability to control vector-borne diseases through conventional insecticides. In the case of malaria, vector resistance has become a major public health problem and indications are that there is a serious problem of effective control of the Anophelene mosquito by chemical methods alone.

Four pesticide management problems can be presently recognized: poisoning, persistence, resistance, and disposal. All are of equal concern to public health and agricultural authorities and each will require carefully thought out strategies of each discipline if they are to be resolved.

In our consortium of universities in the United States called CICP*, we have been deeply concerned with global efficacies of pesticide management practices. Surveys have demonstrated the merits of including an agromedical approach to pesticide management which has now become a central component of integrated pest management strategies. The term "agromedicine" has been defined as "the integrated inter-disciplinary application of the skills and knowledge of agriculture, applied chemistry and medicine, to the safe global production of enough food of high nutritious content to meet the health and nutritional needs of man." The potential of agromedicine becomes more meaningful when a closer look is taken at the realities of the afore-mentioned areas concerned.

PESTICIDE POISONING

In spite of the obvious public health importance of pesticide poisoning, the exact number of cases is not known. Different strategies have been used to try and ascertain the magnitude of the problem. The Director General WHO sent a questionnaire out to all member nations asking them what the status of pesticide poisoning in their country was. Replies were received only from the 10 countries shown in table 1.

TABLE 1
NOTIFICATIONS TO WHO OF ACCIDENTAL POISONING DUE TO PESTICIDES

Country	Year	Number		Rates	
		Cases	Deaths	Cases per 100,000	Deaths per million
Group 1					
Cyprus	1972	15	2	2.3	3.1
Finland	1974	131	16	2.8	3.4
Ireland	1974	141	2	4.6	0.6
Israel	1974	53	—	1.6	—
Quatar	1974	—	—	—	—
W. Samoa	1972	10	—	6.8	1
Summary	–	350	20	2.9	1.7
Group 2					
Roumania	1974	2740	303	13.0	14.4
Syria	1971	1064	167	16.3	25.6
Turkey	1974	1680	156	4.31	4.0
U.K.	1973	98	14	0.20	0.3
Summary		5582	640	4.8	5.5
Group 1: countries 6 million population: total 11.9 million.					
Group 2: countries 6 million population: total 11.5 million.					

Source: J.E. Copplestone, "Safe Use of Pesticides," World Health Organization, 1973.

*CICP Consortium of International Crop Protection

These data were used to make a model on pesticide poisoning incidence and the WHO calculated from this model that there were 500,000 pesticide poisonings per year with a 1% case fatality rate.

In so far as accidental poisoning is concerned, Copplestone had estimated, based on the fact that the world population could be assumed to have passed the 400 million figure in 1977 and using the figures shown in table 1, the actual number of pesticide poisoning deaths might be 4,000 times 5.16 or 20,640 per year. In his review of these statistics, Copplestone further points out that these are accidental poisonings and therefore a disease which should be totally preventable.

Suicide is another important mode of pesticide poisoning. Suicide is not always reflective of a serious depression, but in certain subjects and in certain circumstances, a cry for help rather than determined intent to self-destruct. In these circumstances therefore, it is important to further any national program which will limit the availability of highly toxic chemicals in the home setting. The limited data that are available on pesticide suicides suggest that it is reaching almost epidemic proportions in certain areas of the world. Jeyaratnam, Seneviratne and Copplestone, in their survey of pesticide poisoning in Sri Lanka in 1978, showed that there were over 1,000 deaths due to pesticide poisoning. During the same year there was a total of only 572 deaths due to polio, diptheria, tetanus, and whopping cough, and there were no deaths due to malaria. Suicide was responsible for 66.3% of deaths of males by poisoning and 90.6% of the deaths of females.

Carlos Zapatos from Manila has surveyed pesticide poisoning over a three-year period in the Philippines, and found that 60.17% of the cases were due to suicide.

Suicide has also shown a dramatic increase in Trinidad-Tobago and there was a sharp rise in 1965; this coincided approximately with the importation of highly toxic pesticides into the country.

In his review of pesticide safety, Dr. Copplestone concludes, "in all societies, but especially where literacy is low, probably the most effective single measure to promote safety is restriction of the availability of the more toxic pesticides to those who have been trained in their use, and who have specific need to use them." In order to assist countries in furthering this type of control, WHO has adopted a recommended classification of pesticides by hazards, (WHO 1975). This decision has been a major step towards classification of pesticides in developing countries where poisoning appears to be out of control.

The ultimate solution to acute poisoning rests in further control, education and training.

PERSISTENCE

Persistence comes from the ready availability of fat soluble pesticides in the environment. In food, the presence of residues can have a serious impact on the economics of a nation. For example, El Salvador experienced great problems in trying to export meat. The meat export trade was worth over a million dollars, yet year after year, tests turned up residues of DDT in the meat which were beyond acceptable tolerances. These residues were due to the simultaneous use of DDT in agriculture and the wandering of the cattle from pasture lands into fields where the cotton had been treated by DDT. In addition, cattle were fattened in pens with cotton seed oil which contained high residues of DDT. The same problem is surfacing increasingly in different countries as residues analyses for imported food becomes increasingly required.

TABLE 2.
ALL POISONING ADMISSIONS TO THE PORT OF SPAIN, SAN FERNANDO AND SANGRE GRANDE HOSPITALS RESULTING FROM CHEMICAL EXPOSURES

	Males		Females		Total	
Agent	No. Admitted	Deaths	No. Admitted	Deaths	No. Admitted	Deaths
Paraquat	100	59	78	34	178	93
Tablets	31	1	152	1	183	2
Miscellaneous	64	11	105	7	168	18
Aldrex	22	1	23	2	45	3
Insecticides	28	1	26		54	1
Chlorox	22		50		72	
Kerosene	17		21	1	38	1
Gasolene	10				10	
Rat Poison	6	1	7	1	13	2
Total	300	74	462	46	762	120

Source: Ward Registers and Death Registers of the above three hospitals

The need for pesticide management and the associate problem of persistence call for improved integrated pest management techniques which can effectively control pests without recourse to the organochlorine pesticides, and the simultaneous monitoring of food and the environment for residues of these pesticides.

RESISTANCE

In 1948, it was first noticed that the housefly was becoming resistant to DDT; this was seen in Italy, Sardinia and the United States. By 1949, DDT resistant mosquitoes had been found in the U.S. Afterwards, the resistance problem increased by leaps and bounds. It has been reported that since 1945 the total number of species with resistant strains had risen to 137 divided almost equally between pests of agriculture and those of medical and veterinary importance. By 1965, the results of a world survey of resistance of agricultural pests including insects, mites, plant pathogen and rodents indicated that strains of some 200 species had become resistant. By 1980, resistant strains of some 414 arthropod pests, 152 of which were medically important had been noted.

Michael Dover and Brian Croft addressed this problem very succinctly in a manuscript entitled "Getting Tough: Public Policy and the Management of Pesticide Resistance".

They advocate the philosophy of "resistance management". "Resistance management" should be considered part of an overall integrated pest

management program and should be furthered by appropriate pesticide regulation, incorporating resistance risk into pesticide registration, and allowing mixtures to be registered for use in "resistance management".

DISPOSAL

This is the fourth and most pressing pesticide management problem in the United States. It first surfaced with the Love Canal episode and subsequently led to the special assignment of "Superfund" monies to help clean up toxic wastes. As monitoring increases, so do the multiplicity and magnitude of the hazardous waste sites in the United States and there is special concern for the long-term impact of groundwater contamination.

In Florida, aldicarb or temik, and ethylene dibromide are two very different types of pesticides which have caused and are still causing public health concerns by virtue of the fact that they have been identified in groundwater systems of the state.

Control by regulation

Improved pesticide management through regulation is more likely to be furthered where there are fiscal incentives. The World Bank is in the process of developing guidelines for Third World countries which would tie in the necessary ingredients for safe pesticide management as part of the conditions to obtaining a loan to purchase pesticides. Such an endeavor can greatly advance the safety of the small farmer, particularly if appropriate use is made of what we know of the toxicity and hazard of the available chemicals. For example, regulations should seek to keep the World Health Organization's Hazard Classification Categories I and II out of the hands of the small farmer, owing to the constraints of educating this cadre of end-users on pesticide safety. Only those compounds in Categories III and IV should be available, unless there has been certified pesticide management training. Besides toxicity, another overall consideration is the question of persistence, and again, the farmer's safety and particularly his environment would be furthered by guidelines which dissuade and prohibit the use of the more persistent pesticides.

In addition to furthering pesticide safety, discouraging the use of organochlorine pesticides would facilitate food trade because of the avoidance of undesirable food residues which would exceed the tolerances recommended by the Codex Alimentarious. Thus, besides advocating the removal of the more and persistent pesticides, human safety, particularly poisoning in children can be reinforced by having appropriate safety packaging of pesticides.

The guidelines have yet to be released, but certainly if they address these more obvious characteristics of pesticide safety they should contribute to an overall reduction of human and environmental toxicity.

DISCUSSION

Q. (Dr. Mukunya), Kenya: Asked Dr. Davies why the studies done in USA showed higher body burdens among blacks.

A. (Dr. Davies), USA: This may be due to different domestic practices in applying pesticides.

Q. (Mr. D. Bull), ELC: Who carried out the surveys in the Caribbean? Can the same be done in East and Southern Africa?

A. (Dr. Davies), USA: The studies were carried out by the University of Miami. The cost of blood monitoring is minimal and so there is no reason why this survey cannot be carried out in ESA.

C. (Dr. Kiss), USAID Washington, on Dr. Davies' paper on the agromedical approach. She indicated that while this was desirable, people should not lose sight of the environment approach to pest management.

C. (Mr. Cosse), GIFAP, commented that WHO favored the agromedical approach to solving certain pesticide problems and the WHO representative in each country should be approached so that help can be sought.

It was remarkable that use of pesticides which have no antidotes should be discouraged. Somebody remarked that there are very few chemicals which have antidotes.

C. (Dr. Osman), Sudan, commented that people should be careful when they are giving educational talks which mention that certain pesticides are more toxic as such information may lead others to commit suicide.

Q. (Tukahirwa), Uganda: What training in agro-medicine can be given to small farmers, especially where there is no doctor?

A. (Dr. Davies): Training of such people should be on prevention rather than actual cure.

Classification, Chemistry and Toxicology of Pesticides

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Pesticides are classified or grouped in several ways depending on the purpose. This includes origin, level of toxicity or other biological activity and "restricted vs. general" use.

CLASSIFICATION BY INTENDED USE

Agricultural chemicals, home garden products and other commercial products are determined to be pesticides based solely upon the purpose for which they are marketed. Whether or not a product is legally determined to be a pesticide and required to be registered is largely dependent upon the claims made on its labeling. The term "pesticide" is defined in U.S. laws as "(1) any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest, and (2) any substance or mixture of substances intended for use as a plant regulator, defoliant or disiccant . . .". This definition is followed by language that exempts some product which are subject to regulation under other laws. In addition, the term "pest" is defined.

Pesticides can usually be grouped under the following categories based upon intended use:

Insecticides and Nematocides for use against insects, nematodes and other invertebrate pests.

Fungicides for use against plant diseases caused by fungi, bacteria, viruses or protozoa. Disinfectants and sanitizers used to kill bacteria on inanimate surfaces are also included under the definition of "fungicide".

Herbicides for use against weeds (any plant that grows where it is not wanted).

Plant regulators for altering the growth or maturation of plants.

Plant dessicants for accelerating the drying of plant tissues.

Plant defoliants for causing leaves to drop from plants, (usually as a harvest aid).

Rodenticides and other vertebrate animal poisons or repellents for use against any vertebrate animal (except man).

CLASSIFICATION BY CHEMICAL STRUCTURE OR ORIGIN

Pesticides are sometimes referred to as botanicals, chlorinated hydrocarbons, organic phosphorus compounds, etc. While this type of classification is often meaningful to chemists, it causes some confusion. Many compounds do not fit clearly into any established group, while others may fit into more than one. Most efforts to classify pesticides in this manner result in a mix of chemical and use classification.

No attempt is being made to provide the extension list of such groups; however, a few of the better known chemical groups include:

Organochlorines: the organochlorines are synthesized insecticides that usually contain carbon, chlorine, and hydrogen. They are also referred to by other names such as chlorinated hydrocarbons, chlorinated organics, chlorinated insecticides, chlorinated synthetics, and perhaps others. Examples of insecticides in this group include DDT, aldrin, dieldrin, methoxychlor and many others.

Organophosphates: The organophosphate insecticides have several commonly used names: organic phosphates, phosphorus insecticides, nerve gas relatives, phosphates, phosphates insecticides, phosphorus esters and phosphoric acid esters. They are all derived from phosphoric acid. These insecticides vary widely in toxicity to mammals and some are extremely toxic.

Botanicals: Insecticides and rodenticides derived from plants or plant parts are included in this group. Their chemical structure and mode of biological activity vary widely and some are not well understood. Some examples are pyrethrins, derived from one pyrethrum plant, strychnine, rotenone, derived from the cube roots, nicotine derived from tobacco, and others.

CLASSIFICATION BY LEVEL OF TOXICITY

For purposes of evaluating the risks from exposure and determining the necessary label warnings and precautions, pesticides are divided into four categories. The category of toxicity for a given pesticide is determined by the level of toxic effects on test animals exposed orally, dermally and through inhalation. The LD values or other rates of exposure required to produce adverse effects for each category is shown in table 1 from EPA's regulations.

The precautionary statements required on labeling is determined by the category in which a pesticide is placed. Category I products require the most severe precautionary statements since they are most toxic and additional care is required to prevent injury. The labeling is designed for the formulated product and must be adequate when followed to prevent injury to the user or others who may be exposed.

Certain precautionary statements must be promi-

nently displayed on the front panel of the label while more extensive statements may be placed elsewhere. The signal word "danger", "warning", or "caution", along with the statement, "keep out of reach of children" are normally required on the front panel.

The label of a product placed in Category I based on acute oral, dermal, or inhalation toxicity is required to bear the signal word "danger" along with the word "poison" (in red) and the skull and crossbones.

If a product is placed in Category I solely on the basis of eye or skin irritation, its label must bear the signal word "danger". The skull and crossbones and word "poison" are not required for such products. The label of a product placed in Category II is required to bear the signal word "warning". The label of a product placed in Category III or IV is required to bear the signal word "caution".

Evaluation of exposure and risks as well as determinations on necessary precautionary labeling are made on the basis of tests with laboratory animals. Data from such tests are extrapolated to estimate the risks to man. Such tests include both acute and chronic studies to determine the effect of single or short-term exposures versus repeated or long term exposures.

CLASSIFICATION BY "RESTRICTED USE" VERSUS "GENERAL USE"

In the USA, federal and state laws require that the purchase and use of restricted products be limited to certified applicators or someone under their direct supervision. Pesticides may be classified for restricted use by either the federal or state regulatory agencies and different criteria may be applied. Those pesticides or pesticide uses which have been classified for restricted use are listed in EPA's regulations (40 CFR, 152.160-162.175) along with the criteria applied. These are also shown in an EPA brochure entitled, "Suspended and cancelled pesticides". Pesticides or pesticide uses which are not restricted are considered to be in the general use category.

PESTICIDES NO LONGER RESTRICTED IN THE UNITED STATES

Many pesticides or pesticide use patterns previously registered in the United States have been discontinued during the past 20 years. This has resulted largely from the development of more sensitive analytical methods for determining the level of residues remaining on food or feed crops and in other segments of the environment.

During the 1960's and early 1970's, numerous pesticide use patterns were cancelled after it was determined by new and highly sensitive methods that trace residues remained on harvested crops. Such use patterns not supported by finite tolerances or other formal clearances were cancelled. The development of current methods for toxicological testing in recent years has also invalidated some previous data and

TABLE 1
TOXICITY CATEGORY CRITERIA

Hazard indicators	Category I	Category II	Category III	Category IV
Oral LD	Up to and including 50 mg/kg	50 thru 500 mg/kg	500 thru 5000 mg/kg	5000 mg/kg
Dermal LD	Up to and including 200 mg/kg	200 thru 2000 mg/kg	2000 thru 5000 mg/kg	5000 mg/kg
Inhalation LC actual chamber concentration measured for a 4 h exposure	Up to and including 0.05 mg/lg	0.05 thru 0.5 mg/l	0.5 thru 5 mg/l	5 mg/m
Eye effects	Corrosive (irreversible destruction of ocular tissue) or corneal involvement or irritation persisting for more than 21 days	Corneal involvement irritation clearing in 8-21 days	Corneal involvement or irritation clearing in 7 days or less	Minimal effects clearing in less than
Skin effects	Corrosive (tissue destruction into the dermis and/or scarring)	Severe irritation at 72 h (severe erythema or edema)	Moderate irritation at 72 hr (moderate erythema)	Mild or slight irritation (no irritation or slight erythema)

resulted in cancellations. Lifetime feeding studies in which test animals were exposed to maximum tolerated dosages have shown an increase in tumors or other adverse effects.

Some of the better known examples of previously registered pesticides which are no longer registered for widespread use in the United States are as follows:

DDT — Action to phase out DDT registrations was started in the late 60's based upon data showing that residues remained in various segments of the environment for long periods of time. Concern over possible damage to wildlife, fish and other segments of the environment led regulatory officials to the conclusion that DDT should be cancelled. This action was subject to extensive and lengthy hearings which were culminated with the cancellation of essentially all uses of DDT in June of 1972. By this time, it was decided that DDT presented a cancer hazard to man and it was on this basis that the cancellation was issued.

Cancellation was given to the public health benefits of DDT and the final cancellation action provided for continued registration and use in public health programs.

Aldrin and Dieldrin: Most registrations of aldrin and dieldrin products were cancelled in October 1974 following extensive hearings and other administrative proceedings similar to those of DDT. The uses which were not cancelled included: dipping roots or tops of non-food plants in connection with quarantine programs, sub-surface ground insertions for termite control, moth proofing by manufacturing processes which utilize the pesticide in a closed system.

Chlordane and Heptachlor: In March of 1978 practically all uses of chlordane and heptachlor were cancelled following long and extensive hearings and other administrative procedures. The uses which were not cancelled included: dipping roots and tops of non-foods plants in connection with quarantine programs, sub-surface insertion for subterranean termites.

The above cancellations provided for the use of existing stocks on several of the more important uses with some being used for several years after the cancellation was taken.

These cancellations are indicative of the regulatory positions taken in the United States in recent years. In each case, the lengthy hearings and other administrative procedures involved in-depth considerations of the risks involved and the benefits derived from continued use of the pesticides. The conclusion in each case was based on the presence of trace residues of the pesticide in the food chain, in man, and in various segments of the environment. This was related to test results which showed that lifetime feeding of laboratory animals with massive dosages of the pesticides increased the incidence of tumors. Consideration of the need for, and the benefits derived from continued use within the United States is reflected by the use patterns which were continued. The need for, and benefits from continued use by other countries was considered to be taken care of by the export exemption provision in the law.

The positions taken in the United States on the above cancellations and on numerous others in recent years have been very conservative and weighted heavily on the side of safety or reduced risk. The officials responsible for making such determinations have concluded that this was warranted and proper for the United States. Other nations will, of course, have to make determinations on these issues based upon their own needs, resources and options.

Appendices

Appendix I	— Recommendations from the workshop
Appendix II	— Pesticide management questionnaire
Appendix III	— Workshop program
Appendix IV	Registered participants

Recommendations from the USAID Regional Workshop on Pesticide Management, Nairobi, Kenya March 11-15, 1985

INTRODUCTION

With increased emphasis on the production of food to meet current and future demands in the countries of Africa, the need for pest management and control becomes more important. Loss of food to pests during production and storage currently averages 50%, even in the absence of droughts or unusually severe pest outbreaks. The use of pesticides is a vital part of pest management and control in the countries of East and Southern Africa (ESA) and their use is expected to increase.

The value of pesticides in producing crops, livestock, stored products, and protecting human health is well established in developed countries. The need for pest management and control and the value of proper pesticide use is even greater in ESA countries. However, the potential for injury to people and harm to the environment is increased since growers and other users of pesticides are not normally well trained in proper use and handling of such products.

The need for additional regulation and management of pesticides within ESA countries has been regonized as essential. To encourage the development of a practical and workable regulatory approach, a regional workshop was held in Nairobi, Kenya, in March 1985. Representatives from 11 ESA countries attended and took an active part in the workshop. Participants unanimously concluded that specific recommendations directed to industry, governments, and donors involved in the region would serve to encourage improved pest and pesticide management practices.

These recommendations are as follows.

DONORS

Training

It is recommended that training in pesticide management be given a high priority in the region. This should include long and short-term training of Africans, in Africa and in developed countries, in the technical areas described below. Workshops should be conducted at both the regional and national levels. Regional workshops should focus on the exchange of ideas and information. National level workshops should focus on "train-the-trainer" courses. In regard to these national courses, it was considered critical that an adequate training package be given to each participant so that he/she can extend the information learned.

Workshops should be organized in the following priority areas:

Pesticide safety and effective use.

Pest management for cereal and pulse crops, using pesticides in an IPM program.

Weed management courses, including application techniques for herbicides. Control of parasitic weeds should be focused.

Pesticide residue and formulation analysis.

First aid for pesticide poisoning, with emphasis on the agromedical approach.

Post-harvest pest management, including control of the larger grain borer, *Prostephanus truncatus*.

REGIONAL ACTIVITIES

It is recommended that donors and industry combine resources to establish a regional pesticide analysis laboratory with the capacity to do formulation and residue analyses on an as needed basis. It is desirable that Africans be trained in pesticide laboratory techniques at this regional facility.

INFORMATION EXCHANGE

It is recommended that a United Nations organization like FAO or UNEP prepare a catalogue of information on pesticide use training courses, pesticide residue and formulation courses, where to go for international waste disposal assistance, where to go for legal aid, the schedule for pest management courses and conferences, etc. This catalogue should be updated and distributed to governments in ESA countries on a regular basis.

TECHNICAL ASSISTANCE

It is recommended that both long and short-term technical assistance in crop protection be included as a component in appropriate donor agricultural projects in the region. An integrated approach to pest control is desirable.

In order to upgrade and harmonize pesticide legislation and regulations in the region, it is recommended that technical assistance be allocated to advise and assist national governments in developing this legislation.

INDUSTRY

Protective clothing

It is recommended that the chemical industry in East and Southern Africa compiles a catalogue of available suitable protective clothing, including material specifications, costs and addresses of where this protective clothing can be purchased. Several copies of this catalogue should then be sent to each of the Ministries of Agriculture in ESA countries.

It is further recommended that industry continue to develop protective clothing materials which are comfortable to wear in tropical climates.

Training

It is recommended that industry be encouraged to give scholarships and grants to local African scientists. Also, industry should continue to support donor and national government training programs on an as-requested basis. Increased activities in regional professional societies are to be encouraged.

PACKAGING, LABELING AND SPARE PARTS

It is strongly recommended that all pesticides be packaged and labeled in a responsible manner whether or not this is required by existing legislation. Labeling should be in the appropriate language or languages of each country and in accordance with FAO/WHO specifications. All pesticides should be packaged in sturdy leak-proof containers and measuring devices should be included for the more toxic materials. Dust formulations should be sold in small sachet sizes and liquid formulations should be sold in relatively small containers suitable for use by the small farmer without large amounts of the pesticides being left over. Five hundred grams for dry formulations or 1 litre and 5 litre containers for liquid formulations are recommended.

When spray equipment is sold, a package of basic spare parts should be included. Industry and retailers should keep a good stock of spare parts.

RETAILING WHO 1A AND 1B CLASSIFIED PESTICIDES

It is recommended that industry discourages the retail sale in ESA countries of WHO toxicity classification 1A and 1B pesticides. These toxic pesticides should be sold only to applicators who have been specifically trained by industry in their use. In case of pesticide poisoning, retailers should stock appropriate antidotes.

Pesticide information flow to the farmer

It is recommended that the chemical industry continue to study the best ways to get pesticide use and safety information across to the illiterate farmer. Recommendations should consider the farmer's economic conditions.

Research

It is recommended that industry increase its research efforts in the region.

NATIONAL GOVERNMENTS

Legislation

It is recommended that countries in East and Southern Africa be encouraged to enact strict, but clear and practical legislation, and allocate the necessary resources to regulate and enforce the importation, distribution and use of pesticides.

Legislation should provide for a registration process for pesticides. The FAO model law should be considered as a guide for the preparation of appropriate legislation. Donors and industry could assist in these efforts.

Strict labeling and packaging requirements should be established. The statements regarding labeling recommendations should specify some of the basic elements of minimum labeling such as product name; statement of ingredients which properly identify all active ingredients and inert ingredients which may increase risk to the user; directions for use which lists crops or sites to be treated, dosage rates, timing of applications, preharvest intervals and other necessary use restrictions; precautionary labeling including warning and caution statements which are necessary and if complied with adequate to prevent injury to user or others who may be exposed; net contents statement; name and address of manufacturer, formulator or distributor.

It was recommended that delegates should approach their governments about the possibility of initiating pesticide legislation. If the government's response was positive, the delegate would contact the USAID Regional Pesticide Advisor before the end of June, 1985. If the interest level is high, USAID would likely sponsor a regional pesticide legislation workshop in the future.

Training

It is recommended that courses on first aid procedures for pesticide poisonings be taught to students in medical schools, agricultural institutes, and nursing schools. Pesticide safety and effective use courses should be taught regularly to students in agricultural institutes and to agricultural extension staff.

Training for retailers

It is recommended that sellers of pesticides, especially small-scale retailers, be taught about pesticides. This training should focus on safety aspects, packaging, labeling, and how to use and calculate dosages for the various pesticides sold. Retailers should be trained so that they know that pesticides should be stored away from consumer goods in separate premises.

Research and extension

It is recommended that funds be allocated to continue to research IPM methods on cereal and pulse crops, weeds and post-harvest pests. An allocation of increased research budget is encouraged, especially for getting realistic recommendations to small farmers working under sub-optimal conditions.

Pesticides Management Questionnaire

by
Dr. Ann Stroud

A questionnaire concerning the status of pesticide management was filled out by representatives from national governments attending the workshop. The 11 countries including: Zambia, Mozambique, Zimbabwe, Mauritius, Burundi, Egypt, Uganda, Sudan, Kenya, Malawi and Madagascar, can be considered generally representative of the East and Southern Africa region, although there is country by country variation.

The following information was extracted from the questionnaire with specific reference to the existence of specific factors related to pesticide management, problems encountered in pesticide management enforcement, and mechanisms in use for dealing with various aspects of pesticide management. It is hoped that the presentation of information in this manner will be useful to both participating countries, industry and potential donors.

Regulator board problems	**Country**	**No. Responses**
Financial	S	1
Agri-pesticides ignored in legislation	U	1
Ineffective enforcement agency	U, Mau, Zimb	3
Agriculture not represent on board	U	1
Undertaffed	E, K, Mau	3
Delay in action or none exists	B, Zam, Mal	3
Some items not covered by law	Mad	1

Importation problems		
Difficulty to open letters of credit without foreign exchange	S	1
Red tape time consuming	U	1
Costly	U, Mad, Mal	3
Quality control problems	E, Moz, Mad	3
Transport	B, Mal	2
No comment	Mau, Zimb	2

Registration problems		
No comment	S, Mal, Mau	3
No law	Zam, U	2
Still initial stages	K, Mad, Moz	3
Cheating by agricultural chemical companies	Zimb	1
Lack of coordination between departments	B	1
New compounds introduced with little information	E	1

Use recommendation problems		
None or no comment	S, B, K, Zam, Mal	5
Lack of funds	U, Zimb	2
Lack of trained personnel (farmer)	Mad	1
(extension)	U, E	2
(research)	U	1
Lack of appropriate equipment	U	1
Wrong labeling	Mau	1
Updating not done often enough	Zimb, Moz	2

Facilities for analysis problems		
No comment	Mad, Mal	2
Break down of equipment frequent	K, E	2
More modern equipment needed shortage of equipment, reagents, etc.	S, E, Mau, Zimb, Zam	5
Lack of knowledge and staff	U, E, Mau, Moz	4
No laboratory	B	1
Lack of funds	Moz	1

Problems with timely pesticides distribution		
Transport	Mad, B, Moz, Mal	4
No comment	K, Zam	2
Finance availability effects	S, U	2
Red tape	U, Mau, *Zimb, Moz	4
Stocks not renewed before sale (*sometimes)	E	1

Labeling and purchasing problems		
Original labeling inadequate, incomprehensible to farmers and maybe wrong	Mad, E	2
Large volume packaging is inappropriate	Mad, Zimb	2
Repacked into inadequate containers	Mad, K	2
No comment	S, B, Moz, Zam, Mal	5
Yes, is a problem	U, B, Zam	3
Enforcement difficult	Mau	1

MECHANISMS FOR

Importation of pesticides		
MoA approves, clearance through Ministry of Commerce and Central Bank	K	1
Through international tender issue of import licences	S, Moz	2
Advisory Board of Trade or Ministry of Commerce issues	U, Zam, Mad	3
General tender	E	1
National Bank	B	1
Pesticide Control Board	Mau	1
Government Committee approves Chemical Trade Association imports	Zam	1
Ministry of Agriculture or direct order	Mad	1
Registration		
No system	Mad, Zam, U	3
Test by research, then recommended for use	Mal	1
Companies submit registration data (as per FAO guidelines) to National Agricultural Research Institute, approved by Pesticide Commission and National Director of Agricultural Research	Moz	1
Chemical companies carry out research, submit data to Pesticide Registration Officer who decides on basis of acceptances in country of origin	Zam	1

On basis in country of origin	Mau, F	2
Each department takes own responsibility	B	1
National Pesticide Committee	S, K	2

Use recommendations

New products are tested, recommendations made by research and approved by MAO	K, S, U, E, B, Mal, Mad	7
Government analyst recommends, Pesticide Board decides (based on label)	Mau	1
No comment	Zim, Zam	2
Adapt from neighboring countries	Moz	1

Marketing

Direct order by private firms	Mad, Zim, F, U, K	5
Most tenders	Mad	1
Parastatals	Mal, Zam, Moz	3
Company sales representatives and dealers	Mal, Zam, Zim, K	4
Cooperatives	Zim, E, K	3
Ministry of Health	F	1
Licensed agents	Mau, S	2

Linkage mechanism between research, extension industry

Joint meetings	K, S, Mal	3
Ineffective	U	1
Limited	E, Mau, Moz, Zam, Mad	5
Don't know	B	1
Liaison committee	Zim	1

Pest monitoring and outbreak

Ministry of Agriculture	K, E, Zim, Zam	4
Crop protection department in Agricultural Corporation	S, B, Mad	3
None	U	1
Pesticide Control Board	Mau	1
Chemical company assistance	Moz	1
Department of Agricultural Research		

Environment and/or health issues

National Unit for Environmental Control and Education	Mal	1
MoA research laboratories, MoH, National Council for Scientific Research	Zam	1
Limited handling	Moz, B, F, U, Mad	5
Occupational Safety Board, MoH	Zim, S	2
Ministry of Health, Pest Control Act	Mau	1
National Environment Secretariat, Ministry of Health	K	1

Pesticide management mechanisms

Company research extension farmer	Mal, B	2
Company MoA, MoH, environment pest control products board registration licensing extension users	K	1
Company National Pesticides Committee other relevant committees analysis and crop protection departments extension users	S	1
Co MoA user	U	1
no comment or no direct method	F, Zam, Mad, Moz	4
company Pest Control Board user	Mau	1
Company Research, Extension, users	Zim	1

MAJOR INDUSTRY PESTICIDES SUPPLIES

Company		
Hoescht	Mad, Zam, Moz, Zim, U, S, K	7
Ciba-Geigy	Mad, Moz, Zim, B, E, U, S, K,	8
	E, U, S, K,	8
	S, K	10
Bayer	Mad, Mal, Moz, Zim, Mau, E, U, S	8
Rhone Poulene	Mad, S	2
Union Carbide	Mal, S	2
ICI	Mal, Zam, Mau, E, U, S, K	7
Cooper (Zambia)	Zam	1
International Chemicals	Zam	1
Sumitomo	Moz, E	2
Agricura (RSA) Quimiqal	Moz, Zim	2
National	B	1
Give free to coffee and cotton growers	B	1
Dow	F, S	2
Dupont	E	1
American Cyaramid	E, S	2
Staffer	E	1
Chevron	E	1
BASF	U, K	2
Mard B	U	1
Sandoz	S	1
FBC	S, K	2
Farmoplant	S	1
Poussel-Udat	S	1

	EGYPT	BURUNDI	MAURITIUS	ZIMBABWI	MOZAMBIQUE	MADAGASCAR	KENYA	ZAMBIA	MALAWI	UGANDA	SUDAN
Laws developed	X		X	X	X		X		X	X	X
Enforcement for											
Pesticide storage	X	X	X	X			X		?	X	X
Packaging and labeling			X	X	X		X		X		X
Transport	X		X	X		?	X		X		X
Disposal		X	X	X		?	X		X		X
Use	X	X	X	X			X		X		X
Residues	X			X			X	X	X		X
Importation	X		X	X		X	X		X		X
Marketing	X	X	X	X			X		X		X
Regulatory board	X		X	X	X		X		X	X	X
Foreign exchange problem	X		X		X	X	X	X		X	X
Registration system	X		X	X	X		X		X		X
Use recommendation	X	X	X	X	X	X	X	?	X	X	X
Available to users	X	X	X	X			X	?	X	X	X
Updated	X	X	X	X	X	X	X	?	X	X	X
Pesticide analysis facility	X	X	X	X		X	X	X	X		X
Residue analysis facility	X		X	X			X	X	X		X
Trained chemists	X	X	X	X			X	X	X		X
Storekeepers/distributors trained			X	X							X
Pesticides available on time	X		X	X			X	?	X		X
Pricing policy, credit or subsidy	X	X		X	X	X	X	?	X		X
Safety storage or tansport		X	X	X			X		X		X
Chemical companies responsive to needs	X	X	X	X	?		X	X	X	some times	X
Industry training for users	X	?	X	X			X	X	X	X	X
Standard method of packaging	X		X	X	X				X		X
Training in use and safety	X		X	X	X		X	X	X		X
Coop. mechanism betw. ind/res/extension		?	X	X	some		X		X		X
Infor. on pesticides available to users	X	X	X	X		X	X	X	X	X	X
Infor. in understandable language	X	X	X	X	some		X		X	?	X
Percent of illiterate users	50	X	25	X	?	10	75	80	high	X	in ag. schemes
Pest monitoring	X	X	some	X	X	X	X	X	X		X
Parasitic weed problem	X	X	?	X	X	X	X		X	X	X
Protective clothing available			X	X			X				X
Protective clothing affordable			X								

	EGYPT	BURUNDI	MAURITIUS	ZIMBABWE	MOZAMBIQUE	MADAGASCAR	KENYA	ZAMBIA	MALAWI	UGANDA	SUDAN
Application equipment available	X	X	X	X	X	X	X	X	X	X	X
Application equipment affordable			X	X	X		X	X	X	X	X
Spare parts available	X		X	X			X		some	X	
Training in equipment maintenance	X		X	X		X		?	some	X	X
Agency handling environ. concerns	X		X	X			X	X	X		X
Training on poisoning treatment			X	X		X	?		X	some	X
Antidotes available		?	X	X			X		X	some	X
Agency to gather infor. on poisoning			X	X	some				X		X

X = Yes

Blank = No

? = Don't know

Workshop Program

(Sunday, March 10) Registration

1400 — 1800 Registration

Day 1 (Monday, March 11) Welcome, Overview and Country Papers

0815 — 0900 Registration

0900 — 0915 Official Opening and Welcome. Mr. Wapakala

0915 — 0930 Workshop Objectives and Introductions. (REDSO/ESA, J. Jensen)

0930 — 1000 Pest Problems as Contraint to Agricultural Production. (ICIPE, Prof. Odhiambo)

1000 — 1030 Break

1030 — 1045 Importance of Linking Crop Protection with Crop Production (CICP)

1045 — 1115 Pesticides: How to Decide? (USAID, A. Kiss)

1115 — 1130 Discussion

1130 — 1200 Pesticides: A Strong and Dependable Component of IPM Programs in ESA. (CICP)

Lunch

1330 — 1400 Pesticide Use and Safety in ESA Countries: Past, Present, and Future (REDSO/ESA, J. Jensen)

1400 — 1415 Discussion

1415 — 1445 Country Paper. *Sudan.* Pesticide Use in the Gezira: Past, Present and Future.

1445 — 1500 Discussion

1500 — 1530 Break

1530 — 1600 Country Paper. *Mozambique.* How to Buy Pesticides and Save Foreign Exchange (INIA, J. Compton)

1600 — 1615 Discussion

1615 — 1645 Country Paper. *Malawi.* Pesticide Use by the Cash Crop Farmer.

1645 — 1700 Discussion

1830 — 2000 Reception (Duduville)

Day 2 (Tuesday, March 12) Industry Viewpoint, Working Groups

0830 — 0900 Chemical Industry Viewpoint in Kenya. Pesticide Chemicals Association of Kenya

0900 — 0930 Country Paper. *Kenya.* Pesticide Chemicals Association of Kenya. Does It Really Help the Small Farmer? (Kenya Environment and Human Settlement Secretariat, A. Odipo)

0930 — 1000 Discussion

1000 — 1030 Break

1030 — Lunch Divide up into Working Groups. Each Group Will Be Responsible for One Topic.

Lunch

1330 — 1400 Pesticide Formulation Plants: Are We Protected from Another Bhopal Disaster? (PCA)

1400 — 1430 Pesticides and Genetic Engineering. Are High-Tech Solutions Appropriate for Pest Management Problems in Africa? (GIFAP)

1430 — 1500 Discussion

1500 — 1530 Break

1530 — 1600 Country Paper. *Lesotho.* Co-op Lesotho. Pesticide Sale, Labeling and Distribution to the Subsistence Farmer.

1600 — 1630 Pesticide Advertising and Labeling: An NGO Point of View. (Environment Liaison Centre, D. Bull)

1630 — 1700 Discussion

1830 Dinner Sponsored by Pesticide Chemicals Association of Kenya.

Day 3 (Wednesday, March 13) Field Trip, Free Time

0800 Tour of pesticide packaging and formulation plant, research facilities and other points of interest as time permits.

Lunch

Free time to shop, go to banks, confirm airline tickets, etc.

Day 4 (Thursday, March 14) Legislation, Environment, Working Groups

0830 — 0900 USA Pesticide Legislation and Regulation. Is the Developing World Considered? (CICP)

0900 — 0915 Discussion

0915 — 0945 Pesticide Legislation, Regulation and Enforcement in ESA Countries. What Are the Weaknesses and What Should Be Done to Impove the System? (UNEP)

0945 — 1000 Discussion

1000 — 1030 Break

1030 — 1100 Country Paper. *Zimbabwe.* Pesticide Legislation and Regulation: Does It Really Help the Subsistence Farmer Use Chemicals More Safely?

1100 — 1115 Discussion

1115 — 1145 Country Paper. *Zambia.* How Does Zambia Handle Pesticide Imports Without Proper Legislation? (Ministry of Health, S. Goma)

1145 — 1200 Discussion

Lunch

1330 — 1415 Pesticide Application on Small Farms: Equipment, Calibration, Safety Considerations. (FAO, A. Stroud)

1415 — 1500 DDT, Aldrin and Dieldrin: How Does Their Continued Use Really Affect our ESA Environment? (CICP)

1500 — 1515 Discussion

1515 — 1545 Break

1545 — 1700 Divide up into Working Groups to Complete Discussions of Topic from Tuesday.

1930 — 2030 Showing of Film — "Insect Alternatives"

Day 5 (Friday, March 15) Toxicology, Safety, Recommendations

0830 — 0915 Classifications, Chemistry, and Toxicology of Pesticides (CICP)

0915 — 0945	Pesticide Poisonings in Kenya and other ESA Countries (University of Nairobi, A. Obel)
0945 — 1000	Discussion
1000 — 1030	Break
1030 — 1115	The Agromedical Approach: Can It Work Where There Is No Doctor? (CICP)
1115 — 1145	Linking Government and Private Sector Information to the Farmer (FAO, A. Stroud)
1145 — 1200	Discussion
	Lunch
1330 — 1500	Recommendations from Working Groups and General Discussion of all Topics
1500 — 1530	Break
1530 — 1600	Adoption of Recommendations by Workshop Participants
1600 — 1615	"Let's Get With It" and Official Adjournment (REDSO, ESA, J. Jensen)

Registered Participants

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