PROBLEMS ASSOCIATED WITH PESTICIDE USE IN MALAYSIA

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Abstract

Chemical pesticides are powerful tools in the war against agricultural pests. A large arsenal of pesticides is now available in Malaysia. Excessive and indiscriminate use of pesticides on certain crops has led to several long-term problems. There are reports of adverse effects of pesticides on non target organisms, particularly on freshwater fish and natural enemies of agricultural pests. Significant levels of pesticides are present in leafy vegetables and rice grains. Accidental poisoning of man and his domestic animals is often attributed to poor storage, handling and labelling of pesticides. Several agricultural pests have developed genetic resistance to pesticides. Heavy application of broad-spectrum and long residual insecticides has resulted in pest resurgence and the outbreak of secondary pests. There is also the recent observation of adverse effects of excessive pesticide application on crop growth. To overcome these problems, several positive steps have been initiated by the government, research agencies and universities. These include the regulation of pesticide use through the Pesticide Act, education of farmers, and research into alternative pest control strategies. To solve the problems of pesticide use, the full cooperation of farmers, pesticide manufacturers and consumer groups is necessary.

Introduction

Control of agricultural pests with chemical pesticides provides several short-term advantages over non chemical methods. Pesticides are readily available in the market. They can be applied quickly and efficiently. In addition, many of the newer pesticides (e.g. acylalanines and hydroxypyrimidines) are specific-site inhibitors active against a narrow spectrum of pests. Due to their popularity, a large arsenal of pesticides is now available in Malaysia. There are more than a hundred multi-national and local companies involved in the manufacture, formulation and packing of pesticides, with over 3,000 retail outlets. Sales of pesticides in 1980 amounted to M$160 million (Table 1). Of these, 80% were spent on herbicides, 10% on insecticides and the remaining 10% on fungicides, rodenticides and nematicides.

Table 1 Estimated value of pesticides used in Malaysia in 1980.

Pesticides	M$ (million)	%
Herbicides	131	82
Insecticides	16	10
Fungicides	7	4
Rodenticides	6	4
Total	160	100

Source: MACA (1982).

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To overcome pest problems, Malaysian farmers often resort to the use of pesticides. Based on the degree of usage, it is possible to divide these farmers into three groups:

1) Those who use pesticides regularly even though pest populations are below the economic threshold
2) Those who strive for complete eradication of pests, often upsetting the crop ecosystems
3) Those who use little or no pesticides until outbreaks occur. Large quantities of pesticides are then applied, occasionally by air.

Constraints to pesticide use

Pesticides will remain a powerful tool in modern agricultural production. The inherent drawbacks of heavy dependence on pesticides in Malaysia include:

1) Undesirable side-effects on non target organisms
2) Pesticide residues in plants and plant products, soil and water
3) Poisoning of man and domestic animals
4) Pesticide resistance
5) Pest resurgence and outbreak of secondary pests
6) Adverse effects on crop physiology

1 Undesirable side-effects

(1) Fish toxicity

Pesticide residues often accumulate in the body of non target organisms exposed to them. In Malaysia, the problem is particularly acute in paddy fields where fish culture is traditionally practiced. Fish are maintained in paddy fields until prior to harvesting of paddy. Water is then drained off to allow maturity of grains and the fish are harvested for consumption or for sale. Fish therefore serve as important sources of protein and supplementary income. The decline of the fish population in inland waters, and particularly in paddy fields, is caused by factors including the change over from single cropping to double and triple cropping, and the increase in the use of chemical fertilizers and pesticides (Moulton, 1973; Tan *et al.*, 1973; Yunus and Lim, 1971). Pesticides commonly used in paddy fields are the organochlorines (endosulfan and lindane), the organophosphates (acephate, diazinon, phenthoate) and the carbamates (propoxur, carbofuran, MTMC). Acute toxicity of selected pesticides to *Trichogaster trichopterus*, a common paddy field fish, is shown in Table 2. Endosulfan and azinphos-ethyl are relatively more toxic than the other groups of pesticides. Endosulfan has been singled out as the cause of fish mortality. Water collected from paddy fields that have dying or dead fish often contained significant levels of endosulfan (Table 3) but not α or γ-BHC (Table 4). Analysis of dead fish tissues showed high levels of endosulfan I (0.8μg/g) and endosulfan II (0.3μg/g). Related to fish mortality was the recent outbreak of a skin ulcer disease of paddy field fish in several major paddy growing areas. Although the primary causal factor is not known, pesticide residues have been implicated as one of the factors involved.

Table 2 Acute toxicity of selected pesticides against *Trichogaster trichopterus*, a common paddy field fish.

Degree of toxicity	Toxicity range (μg/ml)	Pesticides	
		Insecticides	Herbicides
1	0.01– 0.1	Endosulfan Azinphos-ethyl	–
2	0.1 – 1.0	Dieldrin Phenthoate Phenthoate + MTMC	–
3	1.0 – 10.0	Carbaryl Lindane Carbofuran Propoxur BPMC	–
4	10.0 – 100.0	Dimethoate Diazinon Malathion	Glyphosate 2,4-D butyl ester
5	100.0 – 1,000.0	Acephate	Paraquat Dalapon MCPA
6	1,000.0 –10,000	–	–

Table 3 Endosulfan residues in paddy field water collected from Tanjong Karang, Selangor.

Samples	Residue levels (μg/ml)		
	Endosulfan I	Endosulfan II	Endosulfan cyclic sulfate
A	0.001	0.001	0
B	0.030	0.012	0
C	0.001	0.004	0
D	0.020	0.006	0.0009
E	0.010	0.006	0.002
F	0.002	0.001	trace
G	0.020	0.006	trace
H	0.001	0.009	trace

Table 4 **Levels of BHC residues in the rice ecosystem in Tanjong Karang, Selangor.**

Rice ecosystem	Residue levels (μg/g)	
	α-BHC	γ-BHC
Soil	0.020	0.046
Water	0.00045	0.00013
Fish	0.038	0.031

(2) Effects on natural enemies of target pests

In their studies on the distribution of natural enemies of insect pests, Yasumatsu and Tan (1981) found numerous species of parasites and predators on most crops. Decline in the population of *Apanteles plutellae* and the failure to establish *Diadegma eucerophaga* in certain vegetable areas were attributed to the intensive use of broad-spectrum insecticides (Lim, pers. comm., 1982). Overreliance and indiscriminate use of pesticides often led to the deterioration in the performance of natural enemies besides exerting pressure on the pests to select for resistance. To re-establish a favorable well-balanced environment for the operation of biological control, MARDI has embarked on an intensive integrated pest control (IPC) program, particularly for rice and vegetable pests.

2 Pesticide residues

Pesticides do not usually give rise to residue problems if they are used under proper agricultural practices. Problems arise when farmers harvest their crops without giving allowance for waiting periods or when pesticides are applied at rates higher than those recommended. These problems exist in many vegetable areas in Malaysia. Although significant levels of pesticides in leafy vegetables have been implicated using bioassay tests (Balasubramaniam, 1974), quantitative data are still lacking.

Significant levels of lindane residues have been detected in rice grains collected from warehouses and milling plants (Table 5). Although present at high levels, up to 80% of the residues

Table 5 Lindane residue levels found in rice grains from warehouses, milling plants and farmers' field.

Location	Lindane residues (μg/g)	Range (μg/g)
Warehouses		
Site 1	9.91 ± 11.31	1.17 – 50.0
Site 2	0.82 ± 0.75	0.02 – 3.35
Site 3	0.45 ± 0.43	0.05 – 1.31
Site 4	0.50 ± 0.39	0.09 – 1.48
Milling plants		
Sungai Besar	0.04 ± 0.008	0.02 – 0.04
Sekinchan	0.01 ± 0.005	0.007 – 0.021
Ulu Thiram	0.03 ± 0.004	0.02 – 0.04
Farmer's rice	Trace	Trace

could be removed by repeated washing with water, a tradition practiced before rice is cooked. Boiling further broke down the residues by 5–20%. Lindane residue level is low in farmers' rice, although the chemical is commonly used in paddy fields to control rice pests.

3 Poisoning of man and domestic animals

In agricultural areas, pesticide poisoning is often a serious problem. For example in Cameron Highlands, a major vegetable area with a small population, pesticide poisoning constitutes approximately 95% of the total poisoning cases. The seriousness of pesticide poisoning in this vegetable area is indicated in Table 6. Most of these poisonings are caused intentionally. Paraquat and metamidophos are the most frequently used pesticides in these poisoning cases. Table 7 gives

Table 6 Pesticide poisoning cases in Cameron Highlands (a vegetable growing area) in Malaysia.

Year	No. of pesticide poisoning cases	No. of cases with death
1980	17	4
1981	20	11
Jan. 1982–April 1982	11	4

Source: Kulasingham (pers. comm., 1982).

Table 7 The nature and number of poisoning cases recorded in government hospitals, 1971–80.

Nature of poisoning	No. of poisoning cases									
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Accidental	2,623	2,354	2,306	2,846	3,174	3,033	2,761	3,172	3,441	3,867
Suicidal	140	189	440	364	403	605	726	811	821	930
Effects of poisoning	631	788	895	838	819	790	770	1,155	1,127	666
Total	3,394	3,331	3,641	4,048	4,396	4,428	4,257	5,138	5,389	5,463

Source: Mahathevan (pers. comm., 1982).

the figures of lethal and non lethal poisoning cases collected from hospital records in the country. There was a 60% increase in the number of poisoning cases over a 10-year period, the majority of which were again caused by pesticides. Poisoning is mainly accidental due to improper storage and labelling of pesticides. Pesticides also killed cattle and other domestic animals (Fig. 1). Poisoning of animals is mainly accidental involving cattle and goats grazing on grasses sprayed with sodium arsenite (now banned). It is interesting to note that the total number of cases of pesticide poisoning in animals has declined sharply since 1976. This is probably due to the withdrawal of sodium arsenite from the market.

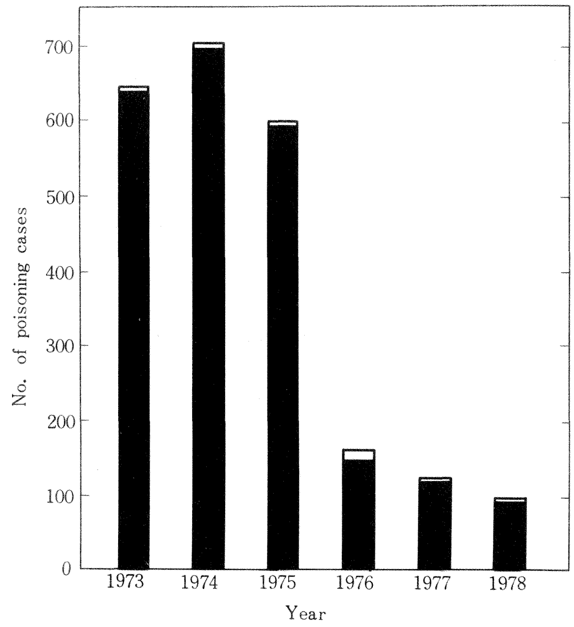

Fig. 1 Animal poisoning recorded by the Forensic Division, Dept. of Chem.

Source: Annual Reports 1973–1978, Dept. of Chem. Malaysia.

4 Pesticide resistance

Reports on the development of genetic resistance of pests to chemical pesticides are numerous (Davidse, 1981; Dekker, 1982; Georghiou and Taylor, 1976). In Malaysia, problem of insecticide resistance in *Plutella xylostella*, a pest of cruciferous vegetables, has been reviewed by Sudderuddin (1979) who noted that resistance to most conventional insecticides is widespread. More recently, the pest has also developed resistance to permethrin (Teh *et al.*, 1982). On storage pests, Carter *et al.* (1975) reported the development of resistance of *Tribolium castaneum* to malathion, resmethrin and tetramethrin plus piperonyl butoxide. *Sitophilus oryzae, Rhyzopertha dominica* and *Tribolium castaneum* had also built up resistance to lindane (Lim, 1974). Development of resistant strains of houseflies (*Musca domestica*) to pesticides in Cameron Highlands is well documented (Singh, 1973; Oh and Sudderuddin, 1975; Lau, 1976). Although not an agricultural pest, resistance in houseflies is important as it affects public health.

5 Pest resurgence and outbreak of secondary pests

Resurgence of insect pest populations and outbreak of secondary pests following application of insecticides have become a widespread phenomenon. Resurgence is attributed to reduction in competitive insect species, destruction of natural enemies, and improved nutritive quality and growth of host plants (McClure, 1977). In Malaysia, Wood (1966) reported the resurgence of several lepidopteran pests of oil palm following heavy applications of broad-spectrum, long residual contact insecticides such as dieldrin, endrin, and DDT. In addition, outbreaks of secondary pests also occurred. On cocoa, use of dieldrin and DDT as high column sprays to control bark borer (*Endoclita hosei*) has led to the outbreak of new pests such as aphids, mealybugs, bagworms, planthoppers and leaf-feeding caterpillars (Wood, 1969). Resurgence of brown planthoppers (BPH) (*Nilaparvata lugens*) on rice was reported by Heong (1981). Dusting with Sogatox(R) (phenthoate 2% + MTMC 2%) gave an initial control of the BPH. Since the chemical has little or no ovicidal effect, BPH population built up from these eggs. Because the chemical was non selective the population of natural enemies was also badly affected. Application of such broad-spectrum insecticides in paddy field therefore resulted in the outbreak of this pest.

6 Adverse effects on crop physiology

Trials of IPC for *Plutella xylostella* on cabbages showed that plots which did not receive permethrin gave 20% higher yield as compared to plots sprayed every three days (Sivapragasam, pers. comm., 1982). Yield reduction was attributed to the adverse effect of permethrin on crop physiology since pest levels in the permethrin-treated plots were significantly lower. Although detailed physiology of permethrin-treated plants was not examined, reports elsewhere (e.g. Sances *et al.*, 1981) had shown that insecticides could adversely affect photosynthesis and transpiration of crop plants.

Approaches to reduce pesticide hazards

Despite the above limitations, pesticides will still remain a powerful tool in modern agricultural production. In Malaysia, several positive approaches have been initiated with the ultimate aim of reducing problems related to pesticide use.

1 Pesticide regulation and enforcement

The Malaysian government passed the Pesticide Act in 1974. Under this Act, all pesticides intended for sale have to be registered with the Pesticide Board effective April 1, 1981. Control of sale of unregistered pesticides was enforced earlier this year in Peninsular Malaysia while enforcement will be effective on September, 1, 1982 in East Malaysia. Other aspects of regulation include licensing, control on advertisement, and labelling requirement. The aims of the Act are:

1) To minimize hazards to user and his environment
2) To ensure that approved pesticides are for intended use only
3) To control residue levels in plant products, soil, water and plants
4) To monitor efficacies and claims of pesticide manufacturers

To date, more than 200 pesticides had been approved for use (Table 8). Registration involves the evaluation of data submitted, toxicological studies, laboratory and field evaluation of efficacies and labelling and packaging requirements. Constraints in the regulation and enforcement include the lack of suitable qualified personnel, and poor transportation and communication facilities in certain parts of the country.

Table 8 Types and number of pesticides registered in Malaysia, 1982.

Pesticides	Number	%
Herbicides	84	38
Insecticides	69	31
Fungicides	43	19
Rodenticides	6	3
Others	21	9
Total	223	100

2 Education

Although there are many innovative farmers who readily accept extension advice on the proper use and handling of pesticides, large portions of the farming community are not fully aware of the potential hazards of pesticides. Many farmers still possess the undesirable habits of smoking or drinking in between spraying jobs. Because of the hot and humid climate, most of them do not wear proper protective clothing. It is not uncommon for farmers to receive safety and health advice from retailers who are themselves unaware of the hazards. It is therefore important to educate the users as well as suppliers of pesticides on the proper storage, handling and application techniques. The Department of Agriculture, through its Extension Branch, distributes information leaflets and posters to farmers. Cooperation among government agencies, educational institutions and chemical companies is vital in the campaign to educate the farmers.

3 Alternative pest control strategies

Research agencies such as the Malaysian Agricultural Research and Development Institute and Rubber Research Institute of Malaysia and various universities are actively carrying out research on alternative methods of pest control. These include the search and utilization of natural enemies, breeding and selection of crops for pest resistance and improvement of cultural practices such as crop rotation and the use of organic amendments. Emphasis is given to IPC, especially for rice and vegetable pests. For example, for rice, there is a collaborative IPC program between MARDI and the Department of Agriculture. It involves the monitoring and surveillance of rice pests, determination of their economic threshold levels, manipulation of natural enemies, and the use of suitable pesticides whenever necessary. Computer-aided population models for pest control are being developed to control major rice pests.

Conclusion

It is generally agreed that there is excessive and indiscriminate use of pesticides on certain crops in Malaysia. This has resulted in the build-up of pesticide resistance and resurgence of some pests. There is a need to monitor pesticide residues in food and the maintenance of pollution-free environment. Pesticides have to be handled with caution, applied in minimal quantities, and at the most appropriate time. They should only be used after thorough research has been conducted on the possible effects on target pests, the host plants and the environment. Pesticide formulations commonly available need to be compared and consideration should be given to factors that influence the choice of formulations for a particular crop-pest ecosystem. Poorly calibrated applicators with improper droplet sizes often result in non effectiveness and wastage of chemicals and contamination of non target areas. Although pesticides are necessary to increase agricultural production, other non chemical methods of pest control are considered necessary. A good example is the recent expedition to collect *Hevea* from Brazil to widen the genetic base of *Hevea* germplasm in Malaysia. There is a need to strengthen facilities for pesticide residue research. Collaborative research between MARDI and international agencies and the setting up of analytical laboratories by the Department of Agriculture are positive steps taken to overcome residue problems. In the final analysis, to solve the problems of pesticide use, we need the full cooperation of farmers, pesticide manufacturers and consumer groups.

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Discussion

David B.V. (India): 1. What is Sogatox? 2. In India, the diamond back moth is also a problem and it is rather difficult to control it. Under such circumstances, your approach of integration of biological control may not be practicable since the damage on cabbage is so extensive that it should affect the marketability of the product. To my mind, it appears that stress should be on the management of pesticide usage with emphasis placed on combinations with a chitin inhibitor and on residue problems.

Answer: 1. Sogatox is a mixture of 2% MTMC and 2% phenthoate. It is used for the control of the brown planthopper and is applied in dust formulation. 2. The farmers are aware of the problem and integrated pest management strategy is being worked out. It will however require some education of the consumers since the vegetable may not appear as clean as if chemical control had been applied.

Thyagarajan, G. (India): Are the natural enemies you listed in your slide indigenous to Malaysia?

Answer: Yes, they are.

Greve, P.A. (The Netherlands): You mentioned the presence of significant levels of pesticide residues in leafy vegetables and in rice. In rice you provide data on lindane. Could you supply data on pesticide residues in leafy vegetables?

Answer: I have not attempted to provide quantitative data for leafy vegetables because high residue levels were only implicated using bioassay tests conducted by the Department of Agriculture. Little work has been done in our Department due to the lack of facilities and manpower. However, on tomato, as high as 12 ppm of bisdithio-carbamate fungicide have been detected.

Ishikura, H. (Japan): 1. You mentioned that you have been enforcing the Pesticide Act since 1974. Is there any clause in the Act which restricts the use of pesticides highly toxic to fish or persisting on crops or soil for a long period of time? 2. You have shown that rice grain in warehouse was highly contaminated with lindane residues. Is this a recent situation? If so, do you still use lindane for post-harvest control of stored grain insects?

Answer: 1. There is no specific clause by such. However, in the registration of pesticides, fish toxicity and persistence of pesticides are two very important criteria. As a matter of fact, there are occasions where pesticides highly toxic to fish are not allowed to be registered. 2. Lindane is still being used. We feel that although residue levels are high, over 80% of it is removed when rice is washed before cooking. Also, the residues have been shown to break down upon cooking.

Kohli, A. (Switzerland): The allegation made that permethrin has a yield-reducing effect seems to be contrary to general experience. Synthetic pyrethroids have been used very widely over the last few years and farmers have usually found that apart from controlling insects, the synthetic pyrethroids usually increase yields. It seems likely to me that the result you have quoted could not be disclosed in future trials.

Answer: In fact this trial is being repeated. What I have reported is a field situation in which a 20% decrease in yield was recorded in cabbage. It is possible that several factors may be incriminated.

El Sebae, A.H. (UNARC/Egypt): Did your studies on fish toxicity include synthetic pyrethroids? Indeed they should have very low LC_{50} values due their high toxicity to fish.

Answer: I have discussed the more commonly used pesticides in paddy fields such as organochlorines which are known to pose hazard to fish. We plan to carry out studies on synthetic pyrethroids in the near future.

Morallo-Rejesus, B. (The Philippines): With the development of resistance to lindane and malathion, which insecticides are being used against stored grain insects?

Answer: Aluminum phosphide applied in fumigations.

Magallona, E.D. (The Philippines): What is the percentage of poisoning cases due to occupational exposure?

Answer: Approximately 90% of the total cases of poisoning are due to pesticides. Unfortunately I cannot show figures on the percentage due to direct contact with the pesticides.

Mochida, O. (IRRI): What is the percentage of mortality caused by pesticides in relation to the total number of deaths in Malaysia?

Answer: I apologize for not being able to give you the breakdown figures. This information could be made available by the hospital authorities of the country.