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Risk assessment and health effects of pesticides used in tobacco farming in Malaysia

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Pesticide poisoning is a global health problem to which tobacco farmers are at risk because of the need for frequent application of pesticide to this insect-prone crop. A cross-sectional, descriptive study of 103 tobacco workers from 50 family farm units in Kelantan, Malaysia, aimed to determine pesticides used, the factors influencing exposure of tobacco farmers to pesticides and the frequency of poisoning among tobacco farmers. Questionnaire, observation and focus group discussions were used to collect data.

The organophosphate (OP) methamidophos, WHO Toxicity Class 1B Hazardous, was used on 96% of farms and was always applied using knapsack sprayers. Twenty-two of 48 knapsack sprayers observed in use were leaking. Training for farmers in pesticide use was minimal, storage and labelling of pesticide containers did not comply with WHO standards, and observed use of protective clothing was significantly less than that reported by farm workers. One-third of workers had two or more symptoms consistent with pesticide toxicity. It was concluded that an improvement in worker education was necessary.

Introduction

Tobacco is an important cash crop with an income per hectare double that of rice (Mohamed 1991), growing well in sandy soil unsuitable for other crops. In Malaysia in 1993, an estimated 45 000 families were economically dependent on tobacco growing, with another 24 000 people involved in the curing process (Dr M Zulkifli, Director, Malaysian Agricultural and Research Development Institute (MARDI) Kota Bharu, pers. comm. 1993). Tobacco is prone to infestation by insects and, despite developments in biological pest control, frequent application of pesticides remains the most common approach to ensure a high quality product at harvest.

Tobacco is a rapidly growing tall row crop, and is worked and sprayed from a deep narrow ditch with inevitable exposure of workers to pesticide. In Malaysia pesticides licensed for use by the National Tobacco Board (LTN), in conjunction with MARDI, are tendered for by chemical companies and purchased by the farmer via a credit system. Accurate statistics for pesticide poisoning are not available from Malaysia because it is classified in Health Department records under the broad heading 'Poisoning or Accident' rather than as a separate diagnosis.

This paper reports on a study of tobacco farmers from Kelantan, Peninsular Malaysia, which aimed to describe the pattern of pesticide use, to assess the health effects resulting from their use and to identify practices which may put persons at risk of exposure, both directly and indirectly during the storage, preparation and application of pesticides. Risk of poisoning by pesticide was assessed in terms of the toxicity of the product used and work practices causing exposure of workers to pesticide. The definitive way of measuring exposure is by whole blood cholinesterase testing and this was carried out on finger-prick samples by a World Health Organization (WHO) recommended field-testing method (Coye et al. 1986; WHO 1986). However, as unpublished data calls into question the validity of

results obtained by this method (Maher, pers. comm. 1985) that information is not presented.

Methodology

This study was carried out in Bachok, one of the major tobacco growing areas in Kelantan, with over 2000 hectares (10%) of land given over to tobacco cultivation (Heong et al. 1987). Tobacco was grown by families who owned or leased small areas of land (plots) located around a village. The sampling units were tobacco farms, defined as a group of people with a common financial interest, working an area of land planted with tobacco. All workers over the age of 15 years in each farm were entered into the study. The spokesperson for the farm gave consent for the questionnaires and structured observation, and was given an information sheet in Bahasa Malaysia.

The study was undertaken in the randomly selected village of Kemasin, which has a population of 1500 people, an estimated two-thirds of whom are involved in tobacco cultivation. Fifty farms cultivating tobacco in 1993 were selected from two different frames, using random number tables in each case. The first was the most recent list of tobacco farmers available from the LTN, comprising 155 farmers registered in 1991. Thirty-one farmers were located; five of these were no longer cultivating tobacco and were replaced with farmers from adjacent farms. The 19 who could not be located were replaced from a second frame formed by mapping the area. A total of 103 workers were interviewed; on 46 farms all the workers were family members. In all farms someone who worked regularly on the farm sprayed the pesticides.

Information on demographic factors, work practices placing workers at risk for exposure to pesticides, and morbidity which could be attributed to pesticide poisoning, were obtained by questionnaire. A list of symptoms which are associated with poisoning by pesticides in use in Kelantan was proffered, specifically asking only for symptoms which had occurred in this tobacco season, on the day of working in the field or the following day. Three focus group discussions, two with male and one with female tobacco workers, included topics: perceptions of health risks of pesticide exposure, spraying practices and perceptions of environmental effects of pesticide use. Three research assistants were trained for the roles of moderator, note-taker and direct translator using the method of Dawson et al. (1992). Participants were selected by two local village headmen and a senior woman.

The origin of farmers' information on pesticide hazard and instructions as to mixing was ascertained by questionnaire. To assess adequacy of transmission of that information we devised Safety Scores. Ten practices employed during preparation and application of pesticides were equally weighted and one point was given for the reported presence of each practice (Table 1). No score was given in the absence of the practice.

Table 1. List of items summed for safety score

1. Long trousers
2. Long-sleeved shirt
3. Mouth and nose cover (mask or cloth)
4. Closed shoes
5. Head cover
6. Gloves
7. Contaminated skin washed immediately
8. Use of a stick to mix pesticides
9. Clothes changed immediately after spraying
10. Body washed immediately after spraying

On each farm the pesticides in use, storage condition and labelling condition were inspected. For random observations of spraying practices, the study area was traversed on foot by the researchers, accompanied by an interpreter, on 6 consecutive mornings. Forty-nine sprayers were observed for 15 minutes or until spraying finished. Clothing and sex were observed for 90 tobacco workers who were not spraying but carrying out other fieldwork. Leakage of knapsack sprayers was recorded as present if clothing against which the knapsack was resting was wet, or if slop from a lidless knapsack or dripping of spray from the wand were observed.

Key informant interviews were held with the Kota Bharu MARDI director for tobacco cultivation and with two officials of the LTN. Persons involved with health services in the district were interviewed.

Information was analyzed using the Epi-Info statistical program (EPI INFO 5, CDC and WHO). A Chi-squared test was used for comparison between groups and ordinal variables (Safety Scores) analyzed (Epi-Info) by Mann-Whitney U tests. The significance level for statistical tests was 0.05.

Results

Pesticides in common use

The organophosphate methamidophos, usually marketed under the tradename Tameron, WHO Toxicity Class 1B Hazardous (Royal Society of Chemistry 1991), was the pesticide reported as most commonly used on 96% of farms. This was supported by observation. On 6 farms the methamidophos was used in fixed combination with a pyrethroid pesticide, WHO Toxicity Class II (Royal Society of Chemistry 1991), and two farms most commonly used pyrethroid pesticides alone. One container of the biological pest control agent *Bacillus thuringiensis* was seen and the owner claimed to use this infrequently.

Malay farmers used a carbamate pesticide, methomyl (trade name Lannate), WHO Class 1B (Royal Society of Chemistry 1991), until its use was outlawed in 1991 because of adverse health effects, described by study members and key informants. Supervision of pesticide use comes under the control of a single enforcement officer, who is in charge of the Bachok District, the entire state of Kelantan and the adjoining state, Trengganu (MARDI, pers. comm. 1993). However, Lannate was still available from imported supplies and three bottles of Lannate were identified.

Pesticide application

Pesticides were applied using knapsack sprayers. Forty-nine were observed in use and 22 (46%) seen to be leaking. There was no officially recognized repair facility in the area. Knapsacks were considered expensive to replace; 16 (32%) were more than three years old. The farmers spent an average of 18 hours each 10 to 12 week season spraying pesticide. A spraying session lasted 20 minutes to 5 hours depending on the stage of plant growth and size of the plot. A fifth of the farmers interviewed sprayed only when there was evidence of insect infestation on the plants. Sixty-nine of the workers had mixed pesticides during the season of whom males (45) were more likely to mix pesticides than females (24) ($p = 0.0001$).

Pesticide concentrate was measured with the measure supplied with the pesticide and added to the knapsack before or after water. Sources of information on preparation of pesticides are given in Table 2. Despite this, focus group discussions concluded that the farmers judged how much pesticide was necessary according to

Table 2. Sources of information on dangers of pesticide and on mixing pesticide: mean safety score by source of information on dangers

	Dangers n = 102	(%)	SS	Mixing n = 69	(%)
1. Fellow farmers	32	(31)	3.7	8	(12)
2. Uninformed	26	(25)	5.1	9	(13)
3. Curer	12	(12)	6.1	22	(32)
4. LTN	11	(11)	5.0	11	(16)
5. Labels	11	(11)	6.6	14	(20)
6. Retailer	4	(4)	5.3	4	(6)
7. Other	2	(2)	N/A	1	(1)
8. Clinic	1	(1)			
Dual sources					
9. LTN and fellow farmers	1	(1)			
10. Fellow farmers and labels	1	(1)			
11. Labels and LTN	1	(1)			

Notes: SS = mean reported safety score, out of 10
LTN = National Tobacco Board

the insect load on the plants and the size of the plants. Twenty-four workers observed mixing pesticide prepared the mixture at a strength of at least double the concentration recommended on the label. The tobacco farmers referred to the capacity of the knapsacks in imperial units whereas measurements on the pesticide containers were always in metric measures.

No farmer waited the recommended 4-week period after spraying before harvesting the leaves. Nine would pick the leaves less than two days after spraying, 11 would harvest when the leaves were ready, 27 would wait 2 to 7 days after spraying and one claimed to wait 10 days.

Pesticide storage and labelling

In most cases pesticides were readily accessible (Table 3) and all were stored in their original containers. All labels were made of paper which deteriorated with continual wetting. The only exception was Lannate; information (in Thai) was printed directly onto the container. On Tamaron bottles, instructions were written in Malay and Chinese and bottles were coded with 'skull and cross bones'. There were no instructions regarding safety precautions or first aid treatment of poisoning, and no batch or reference number.

Table 3. Pesticide storage sites

	n = 46	%
Open shed/bamboo shelter	21	46
Lying in field	13	28
Hanging in bag on post	6	13
In family living space	5	11
In locked shed	1	2

Knowledge on pesticide dangers and precautions for use

Source of information as to the dangers of pesticide use and the mean safety score of workers informed of dangers by a particular source are listed (Table 2). There was no association between individual items and age, sex or source of information.

There was no significant difference in items of clothing reported as being worn while spraying, observed to be worn while spraying or worn while working in the field not spraying, with the exception of gloves and mouth and nose covering. Significantly less people were observed to wear gloves or mouth and nose covering when spraying than reported doing so on the questionnaire (Table 4). Gloves were worn to protect the hands while watering the plants, picking leaves and handling the diesel pump.

Table 4. Wearing of gloves or mouth and nose covering: that *reported* as being worn and that *observed* to be worn

	Observed n = 48	(%)	Reported n = 69	(%)	
Gloves	7	(14)	28	(41)	$p<0.05$
Mouth and nose cover	6	(12)	27	(39)	$p<0.05$

Symptoms of poisoning

One person volunteered he had experienced a problem due to the use of pesticides, complaining of red eyes when he sprayed. The major problem workers volunteered was body pains associated with manual work (13/102). Problems with Lannate in previous years were recalled, but Tamaron was regarded as quite safe. Dizziness and headache were regarded as a normal occurrence after spraying. On direct questioning, headache, dizziness and facial burning were reported most commonly (Figure 1). The difference in the frequency of symptoms in those who did not spray pesticides is not significant, though those who directly handled the pesticide were more likely to blame their symptoms on pesticide. Twenty-five per cent of farmers attributed at least one of their symptoms to pesticides.

No incidents of acute pesticide poisoning had occurred among the study sample or any household member during the study period, or could be recalled from previous years. Action taken in response to symptoms is listed in Table 5. The most common forms of self-treatment were massage or coconut water. Clinic treatment would be sought if vomiting, serious illness or accident occurred. Local clinic staff did not recall seeing anyone with symptoms consistent with pesticide poisoning over the study period.

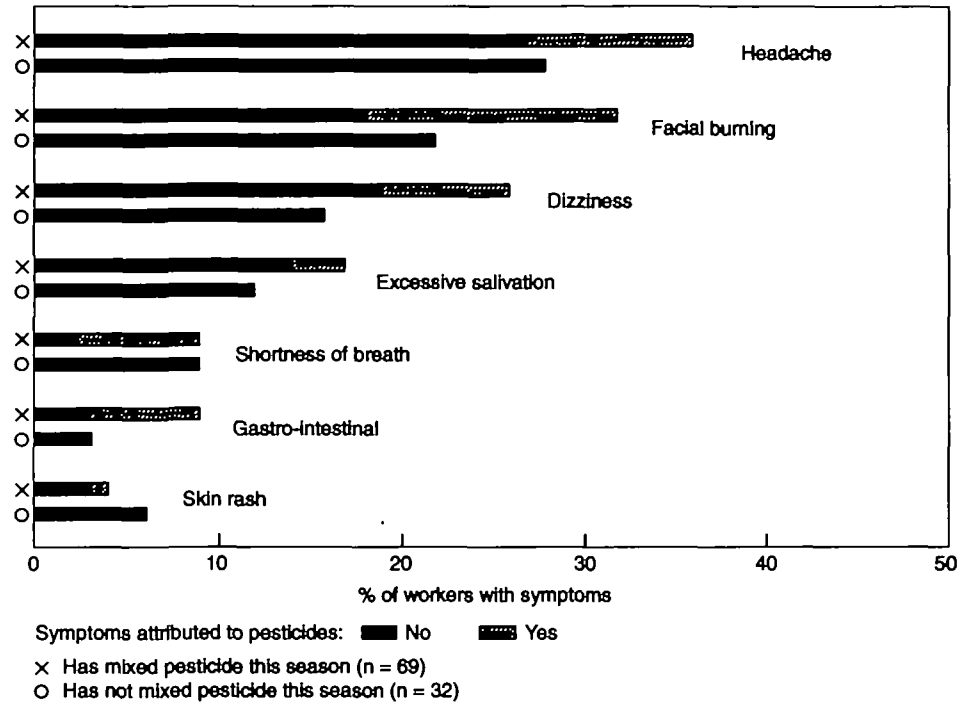

Figure 1. Medical symptoms recorded on direct questioning of 102 tobacco workers in Kemasin

Table 5. Action taken in response to symptoms associated with tobacco farming

Treatment	n = 83	%
Do nothing or rest	33	40
Self-treatment only	31	37
Local clinic or hospital	16	19
Bomah	4	5

Notes: Bomah = traditional healer
One attended both Bomah and local clinic

Discussion

Despite World Health Organization recommendations (WHO 1991) and previous documentation of the paucity of safety education in Malaysia (Heong et al. 1987; Jeyaratnam et al. 1987; Ramasamy and Nursiah 1988), there is still inadequate provision for, and use of, formal training programmes in pesticide use for tobacco farmers in Kelantan. While the items in the Safety Score are clearly not of equal importance, the low scores reflect, in part, poor transmission of safety information.

While financial incentive encourages farmers to buy licensed pesticides in Malaysia, choice within that list depends ultimately on the individual farmer's perception of efficacy (Heong et al. 1987). Methamidophos, the most toxic of the licensed pesticides, is the pesticide most frequently used in Malaysia. The biological pest control agent, *Bacillus thuringiensis*, was not seen in use. The perception that better efficacy can be achieved by compounds other than those recommended may encourage their use and overrule considerations of legality or cost, as evidenced by the continued use of the carbamate, methomyl. At the present time, regulations on pesticides use are not able to be enforced, a problem not unique to Malaysia (Bwititi et al. 1987; Jeyaratnam et al. 1987; Jeyaratnam 1990).

Factors identified elsewhere as placing farmers at risk of contamination with pesticides during spraying were observed in this study; difficulty with label comprehension (*Weekly Epidemiological Review* 1992; Pregno et al. 1991), lack of use of protective clothing (Bwititi et al. 1987; Ramasay and Nursiah 1988; Jeyaratnam et al. 1987; He et al. 1989; *Weekly Epidemiological*

Record 1992) and inadequate maintenance of equipment (Jeyaratnam 1985; Heong et al. 1987). The discrepancy of reported use of mouth and nose cover and that observed was thought to reflect that while nearly half of the workers were aware of recommendations for their use the majority did not wear them. Lack of use of protective clothing has been attributed by other authors to cost and availability (Jeyaratnam 1985) or the unsuitability of protective clothing in tropical conditions (World Health Organization 1985). Despite frequent symptoms after spraying, the workers felt that 'Tamaron' was not dangerous, and this lack of perception of symptoms as a problem may be part of the reason for not wearing protective clothing.

The number of workers with symptoms which could be attributed to organophosphate poisoning are consistent with the previous findings in Malaysia of Heong et al. (1987) and Ramasamy and Nursiah (1988). While subtle neurological changes have been reported at lesser levels of exposure to organophosphate pesticides (Richter et al. 1992), this study limited enquiry to symptoms of acute organophosphate poisoning such as would occur with depression of whole blood cholinesterase activity to less than normal limits. The symptoms of mild and moderate organophosphate poisoning are non-specific (Dreisbach and Robertson 1987), with multiple confounding factors (Bwititi et al. 1987), making it difficult for farmers and local health workers to identify toxicity.

Contamination of finger-prick blood samples may occur with a range of organophosphate pesticides depending on their persistence in the skin (Maher, pers. comm. 1985). Further research is needed into development of a standardized, internationally accepted field-testing method for cholinesterase measurement for workers using the widely used direct cholinesterase inhibitors such as methamidophos.

This study provides an overview of the problems of pesticide use in a localized community in Kelantan, Malaysia. The findings of the study were presented to representatives of the Kota Bharu division of the Malaysian Agricultural Research and Development Institute, and further study is being carried out by the Department of Community Medicine, Universiti Sains Malaysia, Kota Bharu.

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