PESTICIDE USE PATTERNS AMONG SMALL-SCALE FARMERS: A CASE STUDY FROM PHITSANULOK, THAILAND

Pinyupa Plianbangchang[1], Kanchalee Jetiyanon[2] and Sakchai Wittaya-areekul[1]

[1]Faculty of Pharmaceutical Sciences, Naresuan University, Phitsanulok;
[2]Faculty of Agriculture, Natural Resources and Environment, Naresuan University, Phitsanulok, Thailand

Abstract. In this study, 130 small-scale farmers were surveyed regarding pesticide use patterns in rural Phitsanulok, northern Thailand using a structured questionnaire administered via personal interviews and an observational checklist of farmer pesticide storage practices. The survey was conducted during December 2007-January 2008. The results indicate pesticides are readily available and widely used in crop production. This includes the use of endosulfan which has been banned by the Thai government since 2004. Overall, pesticide use was inappropriate. Farmers did not wear suitable personal protection, apply pesticides in an appropriate fashion, or discard the waste safely. They frequently relied on commercial advertisements for the best pesticide to use. Pesticide use patterns among small-scale farmers in Thailand need improvement. Educational interventions are essential for promoting safety during all phases of pesticide handling. Public policies should be developed to encourage farmers to change their pest management methods from chemical based to methods that are healthier and more environmentally friendly.

INTRODUCTION

Thailand covers about 513,000 km^2 and has a population of about 63 million citizens. Of these people, 64.1% live in rural areas. With the exception of Bangkok's highly concentrated industrial sector, Thailand's major source of income and occupation is agriculture. Agricultural contribution to the total GDP was approximately 11% in 2001.

In recent years, concern has been growing that improper agro-chemical use can create hazards for humans and the environment. Along with the green revolution policy of the Thai government, the use of pesticides has skyrocketed over the past 40 years (Health Systems Research Institute, 2005,). In 2002, the amount of pesticides consumed in the country was 39,904 metric tons of active ingredient (World Health Organization, 2006).

The heavy use of pesticides has resulted in various negative health, environmental and economic consequences (Koh and Jeyaratnam, 1996; Satoh and Hosokawa, 2000). National statistics indicate that, in 2006 alone, 1,251 Thai citizens were occupationally poisoned by pesticides (Department of Disease Control, 2007). This number has been criticized by many non-governmental organizations as beeing too low due to

Correspondence: Dr Pinyupa Plianbangchang, Faculty of Pharmaceutical Sciences, Naresuan University, Phitsanulok 65000, Thailand.
Tel: 66 (0) 5526 1000 ext 3620; Fax: 66 (0) 5526 1057
E-mail: pinyupa@nu.ac.th

incomplete records being kept regarding incidence. For example, the estimated pesticide poisoning cases by Green World Foundation were 5,000-7,000 in 2005 (Green World Foundation, 2005). Pesticide exposure and residues were found to be correlated with various ailments among Thai people (Issaragrisil *et al*, 1997; Jirachaiyabhas *et al*, 2004). Past environmental studies found pesticide contamination of the soil and water throughout the country (Thapinta and Hudak, 2000; Boonyatumanond *et al*, 2002; Zarcinas *et al*, 2004). This contamination has resulted in the reduction of natural insect habitats, earthworms, micro-organisms and cover crops. Pesticide residue in agricultural products has not only affected the health of consumers, but has caused the rejection of exported goods, which can lead to economic damage to the country (Health Systems Research Institute, 2005).

To promote appropriate use of pesticides, it is critical to understand the current use of pesticides among small-scale farmers, who are the majority of the Thai agricultural labor force. Until now, there have been no published reports regarding the actual behavior of small-scale farmers regarding pesticide use patterns. For this reason, this study was conducted to explore pesticide use patterns among small-scale farmers in Phitsanulok, Thailand.

MATERIALS AND METHODS

The study was carried out in Phitsanulok, which is located in northern Thailand and covers a total area of 10,815.854 km^2. This is mainly a rural province where the population heavily depends on rice, horticultural (fruits and vegetables), and field (corn and soy) crop production. The majority of these produces are sold on the national market or exported. The survey sites were selected based on the proportion of full-time small-scale farm populations, cooperation from local leaders, and the willingness of farmers to participate. The study protocol was approved by Naresuan University's Ethics Committee.

The data were collected by means of a structured questionnaire administered via personal interviews. The data collected included the farmers' demographic information, farm system and practices, and pesticide use practices. The farmers' pesticide storage practices were investigated by means of a checklist. The instruments were content-validated by an agricultural extensionist and two community development experts, and pretested with farmers in the nearby area who did not participate in the final survey. The survey was conducted during December 2007-January 2008.

Descriptive statistics, such as relative frequencies, were calculated for each question.

RESULTS

Participants

One hundred thirty small-scale farmers voluntarily participated in this study. The majority were females (61.2%). The respondents were 20-80 years of age with an average age of 52 and a standard deviation of 13.3 years. A considerable number either had finished primary school (74.6%) or had received no formal education (10.8%). All farmers reported growing more than one kind of crop on their lands. Rice was found to be the major produce, followed by mangoes, various vegetables and corn (Table 1).

Pesticide utilization

The vast majority (123, 94.6%) of respondents reported using pesticides in crop production, while 66 (50.8%) used chemicals only and 57 (43.8%) combined pesticides with biological/organic pest control methods.

Table 1
General information regarding participants.

Variable	Number (%)
Level of education	
No education	19 (14.6)
Primary school	97 (74.6)
Secondary school	14 (10.8)
Crops (multiple answers possible)	
Rice	120 (92.3)
Horticultural (mangoes and vegetables)	73 (56.2)
Corn	19 (14.6)

Various chemical formulations were reported. All were stated by their trade names without any awareness of the common names. Among them, the most frequently mentioned were insecticides, followed by herbicides and fungicides (Table 2). Some of the pesticides were extremely hazardous or highly hazardous (World Health Organization, 2005). Chlorpyriphos, a pesticide in the organophosphate family, was the most frequently used by farmers, followed by cypermethrin, which is in the pyrethroid family. Glyphosate was the most popular herbicide, whereas the combination of difenoconazole and propiconazole was the most frequently mentioned fungicidal agent. Endosulfan, which was officially banned in October 2004 due to its extreme hazardousness, was found to be used. No farmer had a specific storage site for their pesticides. The vast majority of respondents stored pesticides casually with fertilizers and farm equipment (Table 3).

Availability of pesticides

Pesticides were readily available for purchase by the farmers. All participants reported obtaining pesticides from more than one place (Table 4). The primary source of pesticides in the area was the agro-chemical shops (60%) in the community located 1 to 2 km from their home . Co-operative shops in the community (18.6%) and agro-chemical shops (15.4%) in the municipal market were also frequently mentioned.

Frequency of pesticide application

All farmers used knapsack sprayers for pesticide application. The majority of them reported routine application of pesticides to prevent a pest invasion. Preventive spraying at less than once a month was the most commonly mentioned frequency (40.7%). Some farmers sprayed more frequently than once a week on a routine basis. Only a small number of farmers (16.6%) would wait for the manifestation of the treatment prior to using pesticides again (Table 5).

Pesticide practices

The majority of farmers based their decisions about pesticide use on multiple external sources. The most frequently mentioned source of information was from commercial media/public broadcasts(37.6%), such as television, newspapers or community broadcasting. The second most frequently mentioned source was from government agricultural extension officers (26.4%), followed by village leaders (25%) and finally the opinions of other community leaders (Table 6).

Amongst 123 farmers who reported using pesticides, about 80% said they read the labels on pesticide containers. However, not everyone paid attention to all aspects of the contents, with the majority focusing only on directions (Table 7). None of the participants felt it is necessary to strictly follow the directions.

More than half the farmers used at least one kind of personal protection when handling pesticides. The most frequently mentioned protection included face masks, followed by gloves. The use of boots and long-sleeved shirts were much less frequently mentioned. Approximately 30% of the

Table 2
Types of pesticides used.

Group of pesticides/ Common name	Chemical family	Toxicity class[a]	Status	Number of farmers using it
Insecticides				
Parathion-methyl	Organophosphates	Ia	Registered	1
Methomyl	Carbamates	Ib	Registered	6
Chlorpyriphos	Organophosphates	II	Registered	40
Cypermethrin	Pyrethroids	II	Registered	19
Endosulphan	Organochlorines	II	Banned (Oct 2004)	5
Fenobucarb	Carbamates	II	Registered	3
Abamectin	-	U	Registered	5
Captan	-	U	Registered	1
Unidentifiable insecticides in re-packaged containers	unk	unk	unk	29
Herbicides				
Butachlor+Propanyl 70	-	II (Propanyl 70) and U (Bulachlor) II	Registered	6
Paraquat dichloride	Bipyridiles	U	Registered	6
2,4-D, isobutyl ester	-	U	Registered	8
Atrazine	Triazine derivatives	U	Registered	2
Butachlor	-	U	Registered	1
Glyphosate	-	U	Registered	17
Oxadiazon	-	unk	Registered	1
Unidentifiable herbicides in re-packaged containers	unk		unk	2
Fungicides		U		
15% w/v Difenoconazole + 15% w/v Propiconazole	Azole derivatives	U	Registered	11
Cabendazim (benzimidazole)	-	U	Registered	3
Mancozeb	Carbamates	unk	Registered	2
Unidentifiable fungicides in re-packaged containers	unk		unk	4

[a]Toxicity class as classified by the World Health Organization (2004) where Ia, extremely hazardous; Ib, Highly hazardous; II, moderately hazardous; III, slightly hazardous; U, unlikely to present acute hazard in normal use; unk, unknown.

respondents took wind condition into account while spraying the pesticides. Only 9% reported cleaning up after handling pesticides (Table 7). Interestingly, none of the farmers completely protected themselves according to the concept of personal protective equipment, including the respiratory system, head, eyes and hands, which should all be protected. The reasons given for poor protection were the lack of awareness of

Table 3
Pesticide storage practices.

Storage site (multiple answers possible)	Number (%)
Stored with fertilizers and farm equipment at the farm site, away from the house	34 (21.8)
Stored with fertilizers and farm equipment outside the house	115 (73.7)
Stored inside the house	7 (4.5)

Table 4
Sources of pesticide.

Sources (multiple answers possible)	Number (%)
Agro-chemical shops in the community	210 (60)
Co-operative shops in the community	65 (18.6)
Agro-chemical shops in the municipal markets	54 (15.4)
Convenience stores in the community	15 (4.3)
Direct sale of the agro-chemical companies	4 (1.1)
Village leaders	2 (0.6)

Table 5
Frequency of pesticide application.

Frequency of pesticide application (multiple answers possible, depending on the type of pesticides)	Number (%)
Less than once a month (approximately 1-2 times/season)	59 (40.7)
Once or twice a month	24 (16.5)
Three to four times a month	32 (22)
More frequently than once a week	6 (4.1)
Depends on the pest manifestation	24 (16.6)

Table 6
Sources of information about pesticide use.

Sources of information (multiple answers possible)	Number (%)
Commercial media/public broadcast (including television, community broadcasting, radio, newspaper, leaflets, pamphlets, and billboards)	201 (37.6)
Government agricultural personnel (including agricultural extension officers, and local administrative officers)	141 (26.4)
Village leaders, opinion leaders, and community healthcare volunteers	134 (25)
Neighbors	30 (5.6)
Sales persons from agro-chemical companies	29 (5.4)

Table 7
Pesticide practices.

Variables	Number (%)
Label read	
Yes	99 (80.5)
Every topic on the label	32 (32.3)
Directions only	43 (43.4)
Caution only	23 (23.2)
No	
Personal protection (multiple answers possible)	
Mouth and nose cover	79 (64.2)
Gloves	51 (41.5)
Taking wind condition into account while spraying	38 (30.9)
Boots	26 (21.1)
Long-sleeves shirts	26 (21.1)
Taking a shower after handling	11 (8.9)
Empty pesticide container disposal	
Selling them to peddlers	93 (75.6)
Keeping them at home for other uses	20 (16.3)
Burying them	5 (4.1)
Burning them	4 (3.2)
Leaving them randomly by the field	1 (0.8)
Empty container rinsing	
Yes	0 (0)
No	123 (100)

pesticide hazards (52.4%), the high price of the equipment (25%), and the discomfort due to the hot and humid climate (22.6%).

A large proportion of the farmers (75.6%) reported selling the empty pesticide containers to peddlers. Some farmers (16.3%) kept them for various uses and still others buried (4%) or burnt them (3.2%) (Table 7). No mention was made of rinsing or cleaning empty containers prior to disposal.

DISCUSSION

This study had several limitations. It was conducted on a small group of small-scale farmers in Phitsanulok. Therefore, the results should be considered as a case study. Generalizing these results to the national level should be done with extreme caution. The data relied mainly on the farmers' recollection. Discrepancies might have occurred due to recall bias and social factors.

The results of this survey indicate a wide variety of chemicals were utilized as pesticides in the area. The use of extremely and highly hazardous insecticides, including an agent which was officially banned since 2004 for being extremely hazardous, was observed. Other less hazardous agents create a health risk to the farmers as well. Paraquat, one of the frequently mentioned herbicides, for example, has a lethal dose of only one teaspoonful if ingested. Yet, the agent has been very popular throughout Thailand (Health Sys-

tems Research Institute, 2005).

In this study, insecticides were the most frequently mentioned chemical utilized, followed by herbicides and fungicides. This finding is contrary to the national statistics, which showed that herbicides were the most heavily consumed chemical (Thapinta and Hudak, 2000). This may be due to differences in the types of crops cultivated in the area, for example, mangoes in our study, compared to rice, which is the main crop nationally. In general, weeds grow more rapidly where there is strong sunlight. The mango tree canopy is not suitable for the growth of weeds. For this reason, farmers in our study reported the use of herbicides to the lesser extent than those at the national level.

The majority of farmers used calendar spraying as a preventive measure as opposed to curative application, without much consideraton for health or environmental. Such practices are very common among Thai farmers (Tienmar, 2004,), and have even been found in developed countries (Epstein and Bassein, 2003). Preventive applications may be due to a lack of knowledge about proper pesticide application. Farmers relied mainly on commercial sources for information about pesticides, along with the influence of suppliers whose goal was to maximize their sales volumes, resulting in downplaying the negative impact of pesticides.

Personal protective equipment and personal hygiene were inadequate. The main concern of farmers was to cover their mouth and nose, and this was found to be practiced by just more than half of the farmers. This finding indicates an incorrect knowledge of pesticide routes of absorption, where skin absorption, not inhalation, has been reported to be the most important. This finding is consistent with many other studies that found very little concern regarding handling pesticides (Burleigh *et al*, 1998; Berg, 2001; Matthews *et al*, 2003; Isin and Yildirim, 2007). In less developed countries, adequate protective clothing is often neglected for reasons of discomfort and/or high cost. No national regulations require farmers working with pesticides to observe specific precautions (Wilson and Tisdell, 2001).

Proper pesticide waste disposal is also an important part of responsible pesticide use. Accidental release or uncontrolled discharge of pesticide waste into the environment can harm people and contaminate the environment (Damalasb *et al*, 2008). In this study, the disposal of pesticide containers was found to be careless. Empty pesticide containers may often retain unacceptable quantities of pesticide residue if not rinsed properly (Miles *et al*, 1983). As in many other developing countries where empty pesticide containers are highly valued and sold or exchanged as storage containers for other materials, the majority of farmers in this survey sold empty containers to buyers who picked up the waste from the community. It is unclear what the buyers do with such containers. Damalasb *et al* (2008), strongly against such practices, recommended puncturing empty containers to prevent re-use.

In regards to pesticide acquisition, proximity to stores was the most important factor influencing farmers' practices. The most frequently mentioned source of pesticides was agro-chemical shops in their community. This was especially true considering the remoteness of the survey areas. Although all pesticide shops are legal, previous studies have found great variability in their pesticide selling practices, such as mixing of several pesticides and reselling them in a "cocktail" formula to suit the farmers' pest problems (Health Systems Research Institute, 2005). This practice is dangerous for farmers who would not have complete information regarding the agent they are using.

Proper personal protection and appropriate observation cannot be exercised.

Contrary to concerns regarding the influence of commercial personnel on farmers pesticide use patterns, sales persons from agro-chemical companies were rarely mentioned as a source of pesticide information. This may be because of the small size and isolation of the farm area surveryed, which made the survey areas unattractive for company sales persons. Promotional strategies often utilized for such remote areas are commercial media and public broadcasts, which was the case in this study. In any case, caution should be exercised regarding the misleading nature of the content of the advertisement (Health Systems Research Institute, 2005). For example, advertisements on television regularly used movie stars and celebrities as role models to promote pesticides. Advertisements on the radio rely on a DJ who has absolutely no formal training in agriculture, and are aimed only at changing farmers' beliefs and attitudes toward pesticides. Promotion of pesticides by brand name instead of common names is also widely practiced, especially in the form of sponsors of entertainments or charity events, causing redundant application of the same pesticide in the same field. Some promotional strategies have been regarded as encouraging irrational use of pesticides, such as sweepstake and cash rebate coupons.

Evidence from this survey pointed toward the need for a comprehensive intervention to change farmers' pesticide use patterns. Short- and long-term measures, tackling determinants of inappropriate pesticide use in a holistic manner, should be implemented. This, of course, implies close collaboration between government at different levels and the private sector. The short-term remedy to the problem is to limit access to hazardous pesticides. All class I and II pesticides according to WHO classification should be banned from the market. This measure needs to be coupled with a highly effective implementation, since it was found from this study that a chemical which was banned in 1994 was still being used in the community.

Long-term measures should include an array of activities to empower farmers to healthier choices for pest management. This must include knowledge of chemical hazards which should be disseminated to all farmers. Knowledge regarding personal protective equipment should be propagated. Unfortunately, knowledge alone rarely translates into practice (Murray and Tayler, 2000; Kunstadter *et al*, 2001). A broad variety of factors play a role in shaping farmers' actual pesticide practices since they act rationally within the context of their available resources and socioeconomic objectives (Rola and Pingali, 1993). Presently, chemical pesticides are currently the cheapest and most effective means to for pest control in the short run. The agents have been subsidized by the government to accelerate national crop production. Moreover, the popularity of chemical pesticides stems from their rapid action and prolonged duration. Together with the credit system widely practice in Thai society, these agents are currently considered the most cost-effective means of pest management for farmers.

For this reason, other safe and cost-effective alternatives to chemical pesticides must be promoted along with education. Integrated Pest Management (IPM), which was introduced into Thailand in the 1980s, has proved to be effective in reducing pesticide use and improving the health of farmers in many countries (Konradsen *et al*, 2003). IPM is an ecological approach to plant protection, which encourages the use of fewer pesticide applications (Food and Agriculture Organization of the United Nations, 2008). The technique is actually

series of pest management evaluations, decisions and controls involving cultural, mechanical, physical, biological and chemical strategies in pest management. This implies an individualized, not a one-size-fit-all, approach to pest management. This idea has been quite slow in gaining acceptance in Thailand. Its practical approach does not totally reject chemical pesticides, which have long been used by farmers in Thailand, therefore IPM should be acceptable as a pest management alternative. For IPM to be adopted, any incentive for pesticide use must be removed. Government policy plays a prominent role in this process.

Since the majority of farmers in Thailand are low-income, the initial cost of switching from pesticides to more environmentally friendly and healthy methods should be seriously investigated. A recent study found cost to be an important predictor for small-scale farmers to switch to a biological fertilizer (Jetiyanon *et al*, 2007). Government subsidiary in terms of market finding, product price insurance may well be incentives for switching.

In conclusion, the study indicates inappropriate pesticide use among small-scale farmers in Phitsanulok, Thailand. Findings of this study clearly suggest that it is necessary to reduce possible health and environmental risks associated with pesticide use by documenting risk perceptions and developing ways to address them. Further studies are warranted to generate appropriate data on which to base policies.

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