FACTORS INFLUENCING PESTICIDE USE-RELATED SYMPTOMS AMONG RICE FARMERS IN SUKHOTHAI PROVINCE

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ABSTRACT: The objective of this cross-sectional analytical research was to ascertain relationships between socio-demographic factors, pesticide use history, and self-protective behaviors and pesticide-related symptoms among 420 rice farmers in Kongkrailat District, Sukhothai Province, Thailand. The data were collected using standardized, pre-tested questionnaires in March 2006. Subjects were selected by multi-stage random sampling. Chi-square statistics were calculated to assess relationships between independent and dependent variables. Study results showed that income and marital status were more strongly associated with symptoms than were age and education level. Unexpectedly, subjects who had never been trained in safe pesticide use generally reported lower symptom rates than subjects who had been trained. Frequency of pesticide use and concentration had strong association with symptoms and stronger association than duration of using pesticides as rice farmer, duration of each pesticide application, number of pesticides mixed, main duty in handling, and method of pesticide use. Findings suggested presence of a sensitive subgroup, who developed symptoms quickly after starting to apply pesticides. Self-protective behaviors during application were less strongly associated with symptom rates than were such behaviors before and after application. We recommend that the authorities in occupational health and health promotion should be concerned about pesticide use and self-protection behaviors and promote methods such as integrated pesticide management for rice farmers.

Keywords: Pesticide; Symptoms; Risk factors

INTRODUCTION: Thailand is currently the second-leading country in exporting rice products to the world market and one of the biggest users of pesticides in the South Asia region[1]. In Thailand, most pesticides are used in rice farming. The rice farmers use them with the expectation to kill insect and grass, protect their crops, and get more benefit from the crops. These are the main reasons for this researcher's interest in pesticide use among farmers, especially rice farmers. Moreover, it raises two main questions: 1. How do Thai rice farmers practice preventive behaviors regarding pesticide exposure? 2. What are the factors that influence their practicing these behaviors, and that influence occurrence of pesticide-related symptoms? These questions are important and necessary to address.

Pesticides are widely available in Thailand. The "green revolution" has resulted in immense agricultural productivity throughout the world over the past half century. An important part of the technological innovations accompanying this revolution is the introduction of a variety of chemicals generically known as "pesticide" in the farming areas. Moreover, under "liberalization" of the trade system, many pesticides were imported into Thailand for use with commercial planting in agricultural farms. Pesticides are sold in market with more than 2,000 brand names. However, two types of pesticide are mostly used, namely insecticide (51%) and herbicide (38%). This remains true even though since 1997 82 kinds of pesticides have already been banned in Thailand [2].

Pesticides can cause a lot of dangers or harmful effects to users if farmers use them inappropriately. The acute effects of pesticide exposure range from mild to fatal. They may include symptoms such as skin reactions and eye burns, headache, nausea, blurred vision, muscle cramping, vomiting, and difficult breathing. Information on the chronic health effects of pesticides suggests that they might

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be carcinogenic[3] although this has not yet been proved.

From reviewing many data from the past to present, it was found that the Thai farmers, especially the rice farmers, still use pesticide inappropriately. Statistics from the Ministry of Public Health on occupational poisoning show some decreasing number from a high of 5,154 in 1989 to 3,165 in 1994 although there has been no change in the type of pesticides used or the application of technology. The study estimated that there could be up to 39,600 pesticide-poisoning cases per year [4].

The problem of inappropriate pesticides usage among agriculturist farmers is an important concern for the Ministry of Agriculture[5]. Pesticide use within the year before enrollment was not associated with symptom count. Only associations with insecticides and fumigants persisted when all four-pesticide groups were examined simultaneously. Among chemical classes of insecticides, associations were strongest for organophosphates and organochlorines. Associations with cumulative exposure persisted after excluding individuals who had a history of pesticide poisoning or had experienced an event involving high personal pesticide exposure[6]. These results suggest that self-reported neurological symptoms are associated with cumulative exposure to moderate levels of fumigants and organophosphate and organochlorine insecticides, regardless of recent exposure or history of poisoning[6]. In Thailand, it is not known how long symptoms persist after exposure. The objective of this cross-sectional analytical research was to ascertain relationships between socio-demographic factors, pesticide use history, and self-protective behaviors (independent variables) and pesticide-related symptoms (dependent variables) among 420 rice farmers in Kongkrailat District, Sukhothai Province, Thailand.

MATERIALS AND METHODS: This research was a cross-sectional analytical study, which studied socio-demographic characteristics, pesticide use behaviors, self-protection behaviors, and their relationship to pesticide-related symptoms in rice farmers. The target population of this research was all rice farmers who lived in Kongkrailat district, Sukhothai province. The selection criteria were rice farmers who were at least 15 years old. Multi-stage random sampling was implemented for selecting subjects. Previous studies were used to provide a basis for sample size calculation and summarized reported rates of illness and symptoms, in relation to different exposure levels, as observed in these studies. Then calculated sample sizes that were necessary to detect the observed differences. For specific calculation, data from [7]Yassin et al. was used as a basis. Calculation was made using Epi Info 2000, Statcalc, Sample size and Power, Cohort Cross-sectional (Confidence = 95%, Power = 80%), 82% and 92% symptom prevalence with lower and higher exposure, respectively. This gave a sample size requirement of 392 subjects. As mentioned above, 420 subjects were sufficient to detect most of the pesticide exposure-related differences in symptoms and illness that had been observed in previous studies. Questionnaires were developed from Sorat Warisara[8] and the Agriculture Health Study of USA (AHS). The research was explained to potential participants who indicated consent by returning questionnaires.

The instrument of this research was standardized interviewer - administered questionnaire, which consisted of 4 parts included Socio-demographic factors (independent variables): age, gender, marital status, education level, member of household, family' monthly income, trained in safe use of pesticides, Pesticide use factors (independent variables): Duration of using pesticides as rice farmers, Duration of using pesticide as rice farmer, Frequency of pesticide use last year, The concentration of pesticide use, Duration of each pesticide applying, Duration since most recent use of pesticide, Method of pesticide use, The number of pesticide mixed for applying, Duty in handling pesticides, Self-protection behavior (independent variables): comprised of total 29 questions concerning with their practicing in term of frequency to perform it. The levels of

performing self-protection behaviors were categorized based on median cut point value with high and low. Pesticide-Related Symptoms (dependent variables): There were 32 symptoms specified in the questionnaire. These were categorized into 5 groups by organ system as: neuromuscular (15 symptoms; dizziness, headache, twitching eyelids, blurred vision, insomnia, staggering gait, seizure, shaky heart, exhausted, sweating, muscle weakness, tremor, muscle cramps, excessive salivation, and numbness), respiratory (8 symptoms; burning nose, nose bleed, runny nose, dry throat, score throat, cough, chest pain, and wheezing), digestive (3 symptoms; nausea, diarrhea, and stomach cramps), eyes (3 symptoms; burning-stringing-itchy eyes, red eyes, and excessive tearing), skin/nails (3 symptoms; skin rash, itchy skin, and malformed-discolored-loss of nails).

The questionnaires were pre-tested in 30 farmers in Dongdeay sub-district in Kongkrailat district that was not chosen in first stage of sampling. Pilot test was used for clarity of questionnaires, if pilot subjects did not understand some words or difficult to answer, researcher would change them for clarity. However, some questions that were difficult to understand such as frequency of pesticide use last year and symptom history were clarified for the final version. Descriptive statistics including frequencies and percentage are used for socio-demographic factors, pesticide use behaviors, self-protective behaviors, and pesticide-related symptoms. Mean, median, and standard deviation (S.D.) of score were calculated in the socio-demographic, pesticide use behavior, self-protective behaviors, and pesticide-related symptoms. Chi-square was used to find relationship between independent variables and dependent variables. For all of statistical test used in this study, the statistically significant level was set at alpha = 0.05 (that is, p-values < 0.05 were considered statistically significant. P-values between 0.05 and 0.10 were considered marginally significant.

RESULTS:

The proportion of male subjects (59.5%) was slightly higher than that of female subjects and most of rice farmers (77.9%) were older than 34 years of age. The average age was 42.66 years. Most subjects (83.1%) were married, and most of them (81.0%) had education level at primary school. Most subjects (88.3%) had household size at least three persons, and average of 3.81 persons. Most subjects (73.8%) had family' monthly income equal or less than 10,000 baht or less, average at 8,782.10 baht, and most (83.7%) had lived in Kongkrailat district more than twenty-five years. Most of rice farmers (77.1%) had never been trained in application of pesticides by a government agency. Most (96.4%) used insecticides, and most of them (97.4%) did not plant crops in addition to rice. Most (94.5%) used pesticides in the morning. Socio-demographic characteristics are summarized in Table 1. Age was highly correlated with duration of residence in Kongkrailat r = 0.816, p<0.001), so the latter was not specifically analyzed in relation to dependent variables. After summarizes smoking and drinking by gender, forty percentages of male subjects were smoking. All but 2 smokers were males. Most subjects (64.9%) did not drink. The great majority of drinkers were males. Regarding subjects' medical histories, 358 subjects (85.2%) had never been diagnosed with queried illnesses; however, 21 subjects (5.0%) had hypertension, and 12 subjects (2.8%) had thyroid disease. These numbers were considered too small to allow meaningful analysis of medical history in relation to other independent or dependent variables.

Table 1: Number and percentage of subjects by socio-demographic characteristics (n = 420)

Demographic characteristics	N	(%)
Gender		
Male	250	(59.5)
Female	170	(40.5)
Age group (years)		
≤ 34	93	(22.1)
35 – 44	133	(31.7)
45 – 54	120	(28.6)
≥ 55	74	(17.6)
$\bar{X}$ = 42.66, SD.= 12.15, Min = 15, Max = 73		
Marital status		
Single	54	(12.9)
Married	349	(83.1)
Divorced/separated/widowed	17	(4.0)

Demographic characteristics	N	(%)
Education level		
Illiterate or primary school	340	(81.0)
Secondary school (grade 7 – 10)	45	(10.7)
High school / > high school	35	(8.3)
Household size (persons)		
1 – 2 persons	49	(11.7)
3 persons	141	(33.6)
4 persons	138	(32.9)
5 – 10 persons	92	(21.9)
$\bar{X}$ = 3.81, SD.= 1.31, Min = 1, Max = 10		
Family monthly income (Baht)		
≤ 5,000 baht	190	(45.2)
5,001 – 10,000 baht	120	(28.6)
>10,000 baht	110	(26.2)
$\bar{X}$ = 8,782.10, SD.= 7,356.77, Min = 1,250, Max = 60,000		
Years lived in Kongkrailat District		
1 – 25 years	69	(16.4)
26 – 40 years	138	(32.9)
41 – 72 years	213	(50.7)
$\bar{X}$ = 40.21, SD.= 13.35, Min = 2, Max = 72		
Ever been trained in safe pesticide use		
Never	324	(77.1)
Ever	96	(22.9)
Time of day generally use (May answer more than one, thus adds to >420)		
06.00 am – 09.00 am	397	(94.5)
09.01 am – 04.00 pm	18	(4.3)
04.01 pm – 06.00 pm	118	(28.1)

Pesticide use factors, Most of subjects (75.7%) had worked as rice farmer more than ten years, and most of them (75.0%) had used pesticide as rice farmer equal or more than ten years or more. However, for average time between working as rice farmer (23.85 years) and using pesticide (14.75 years) were different. Most of subjects (72.9%) used pesticides more than seven days in the last year, with an average of 12.80 days. All of subjects read label before using pesticide, and most of them used pesticides amount of as recommended. Duration of each spraying was 3.43 hours on average. Most of subjects (85.7%) had duration since most recent expose to pesticide more than seven days, average 43.64 days, and the main method that they used was spraying. Most subjects (83.6%) mixed 3 or more kinds of pesticides, and most of them (66.0%) had duty in handling both mixing and applying. These characteristics are summarized in table 2

Practice in self-protection scores were developed for each of the 4 aspects of self-protective behavior for each aspect separately, the median score was used to divide the subjects into 2 groups with high and low scores. (Higher score means better self-protection.) Seventy-nine percent of the subjects had high score level while mixing (before applying) pesticide with total possible scores 15, and median scores 12, and 61.7 percent of them had high score level while applying pesticides with total scores 36 and median scores 25. Most of subjects (92.1%) had high score level after use pesticides with total possible scores 18, median scores 18, and most of them (79.3%) had high score level on day not using pesticides with total scores 18 and median scores 17. Total score for all self-protective behaviors combined was high in 54.0% of subjects, and the median was 73 from the maximum possible score of 87. Results for self-protective behavior scores are summarized in Table 3. A total of 32 symptoms were considered as dependent variables. These were organized into the following 6 categories: neuromuscular, eye, respiratory, digestive, and skin/nail symptoms, and symptoms of any organ system. The major neuromuscular symptoms that subjects had during or within 24 hours of pesticide use were exhaustion (35.0%). Major eye symptoms were burning-stinging-itchy eyes (10.0%), respiratory symptoms were dry throat (28.8%), digestive symptoms were nausea (8.6%), and skin/nails were itchy skin (10.0%). In part of symptoms that they had within last year, neuromuscular symptoms were exhausted (38.1%), dizziness (36.7%), sweating (31.7%), muscle weakness (20.2%), eye symptoms were burning-stinging-itchy eyes (12.6%), respiratory symptoms were dry throat (32.1%), digestive symptoms were nausea (15.5%), and skin/nail symptoms were itchy skin (19.3%).

Table 2: Number and percentage of subjects by pesticide use factors (n = 420)

Pesticide use factors	N	%
Duration of working as rice farmer (years)		
1 – 10 years	102	24.3
11 – 20 years	87	20.7
21 – 30 years	107	25.5
31 – 60 years	124	29.5
$\bar{X}$ = 23.85, SD.= 13.50, Min = 1, Max = 60		

Pesticide use factors	N	%
Duration of using pesticide as rice farmer (years)		
1 – 9 years	105	25.0
10 – 19 years	191	45.5
20 – 54 years	124	29.5
$\bar{X}$ = 14.75, SD.= 10.11, Min = 1, Max = 54		
Frequency of pesticide use in the last year (days)		
1 – 7 days	114	27.1
8 – 14 days	210	50.0
15 – 85 days	96	22.9
$\bar{X}$ = 12.80, SD.= 11.69, Min = 2, Max = 85		
Concentration of pesticide used		
Less than/same as recommended	334	79.5
More than recommended	86	20.5
Duration of each pesticide spraying (hours)		
1 – 2 hrs	107	25.5
3 hrs	136	32.4
4 hrs	104	24.8
5 – 10 hrs	73	17.4
$\bar{X}$ = 3.43, SD.= 1.43, Min = 1, Max = 10		
Duration since most recent expose to pesticide (days)		
1 – 7 days	60	14.3
8 – 30 days	203	48.3
31 – 180 days	155	36.9
181 – 240 days	2	0.5
$\bar{X}$ = 43.68, SD.= 43.65, Min = 1, Max = 240		
Method of pesticide use		
Spraying	192	45.7
Spraying and scattering	228	54.3
The number of pesticides mixed for spraying		
Only one or two kinds	69	16.4
Three kinds or more	351	83.6
Duty in handling pesticides		
Mixing pesticides only	64	15.2
Applying pesticides only	41	9.8
Both mixing and applying pesticides	277	66.0
Any other responsibility	38	9.0

Table 3: Number and percentage of the subjects by self- protection behaviors in pesticide use (n = 420)

Self- protection behaviors	N	%
Days when using pesticides		
While mixing pesticides (Maximum possible score = 15)		
High (score 12 – 15)	332	79.0
Low (score 5 – 11)	88	21.0
Median = 12, Minimum = 5, Maximum = 15		
While applying pesticides (Maximum possible score = 36)		
High (score 25 – 34)	259	61.7
Low (score 11 – 24)	161	38.3
Median = 25, Minimum = 11, Maximum = 34		
After applying pesticides (Maximum possible score = 18)		
High (score 18)	387	92.1
Low (score 13 – 17)	33	7.9
Median = 18, Minimum = 13, Maximum = 18		
Days when not using pesticides (Maximum possible score = 18)		
High (score 18)	333	79.3
Low (score 11 – 17)	87	20.7
Median = 18, Min = 11, Max = 18		
Total self-protection (Maximum possible score = 87)		
High (score 73 – 85)	227	54.0
Low (score 54 – 72)	193	46.0
Median = 73, Minimum = 54, Maximum = 85		

Most subjects (52.9%) had neuromuscular symptoms during or within 24 hours after using pesticides, and 60.2 percent of them had any symptoms during or within 24 hours after use pesticides. Subjects with neuromuscular symptoms within last year (62.9%), last six month (52.6%), last month (30.5%), and last week (11.7%) in Table 4.

Table 4: Number and percentage of the subjects with symptoms of organ systems (n = 420)

Symptoms	During or within 24 hrs		Within last year		Within last 6 months		Within last month		Within last week	
	N	%	N	%	N	%	N	%	N	%
Neuromuscular	222	52.9	264	62.9	221	52.6	128	30.5	49	11.7
Respiratory	142	33.8	176	41.9	144	34.3	75	17.9	23	5.5
Digestive	43	10.2	87	20.7	42	10.0	19	4.5	5	1.2
Eyes	61	14.5	78	18.6	51	12.1	26	6.2	11	2.6
Skin/nails	49	11.7	92	21.9	49	11.7	26	6.2	11	2.6
Any system	253	60.2	280	66.7	249	59.3	142	33.8	52	12.4

Table 5 shows that socio-demographic factors: age had significant relationship with any symptoms during or < 24 hours after pesticide use. There was no consistent association of household size with symptoms. Family' monthly income had significant relationship with neuromuscular, respiratory, and any system. Training in safe pesticide use had significant relationship with ever during or < 24 hours after pesticide including any system (p = 0.029).

Table 5 Relationships between factors and pesticide-related symptoms within ever during or < 24 hours after pesticide use

Factors \ Symptoms	Neuro-muscular	Respi-ratory	Digestive	Eyes	Skin/ nails	Any symptoms
	p-value	p-value	p-value	p-value	p-value	p-value
Socio-Demographic factors						
Gender	0.712	0.170	0.395	0.846	0.327	0.746
Age group	0.062	0.340	0.168	0.594	0.541	0.004*
Marital status	<0.001*	0.001*	0.070	0.025*	0.054	<0.001*
Education level	0.149	0.068	0.887	0.421	0.503	0.332
Household size	0.984	0.880	0.829	0.072	0.935	0.914
Family's monthly income	0.005*	0.001*	0.708	0.762	0.052	0.001*
Trained in pesticide use	0.055	0.720	0.110	0.193	0.772	0.029*
Pesticide use factors						
Duration of using pesticide as rice farmer (years)	0.225	0.017*	0.718	0.580	0.186	0.026*
Frequency of pesticide use (day)	<0.001*	0.351	0.295	0.392	0.152	<0.001*
Concentration	0.011*	0.011*	0.202	0.389	0.459	0.047*
Duration of each spraying(hours)	<0.001*	0.308	0.961	0.780	0.602	0.004*
Method of pesticide	0.142	0.004*	0.832	0.806	0.300	0.006*
Number of pesticide mixed	0.687	0.016*	0.684	0.994	0.226	0.233
Main duty in handling	<0.001*	0.532	0.556	0.993	0.306	0.001*
Practice in self-protection						
While mixing pesticides	0.003*	<0.001*	<0.001*	0.002*	0.032*	<0.001*
While applying	0.220	0.008*	0.873	0.303	0.315	0.997
After applying	0.098	0.001*	0.006*	0.099	0.004*	0.008*
Day when not using	<0.001*	0.510	0.406	0.419	0.285	<0.001*

* Significant level at p-value < 0.05

Duration of using pesticides as rice farmer had significant relationship with symptoms including respiratory (p = 0.017), and any system (p = 0.026). Number of days of pesticide use in the last year had significant relationship with symptoms ever during or < 24 hours after pesticide use including neuromuscular (p < 0.001), and any system (p < .001). Concentration of pesticide used had significant relationship with symptoms including neuromuscular (p =0.011), respiratory (p = 0.011), and any system (p = 0.047).

Duration of application sessions had significant relationship with symptoms including neuromuscular (p <0.001), and any system (p = 0.004). Methods of pesticide use had significant relationship with symptoms including respiratory (p = 0.004), and any system (p = 0.006). Number of pesticide mixed had significant relationship with symptoms including respiratory (p = 0.004). The highest duty was both mixing and applying. Main duty in handling had significant relationship with symptoms

including neuromuscular (p <0.001) and any symptoms. There were groups of behaviors that included while mixing (before applying), while applying, after applying, and day not using.

Somewhat unexpectedly, the overall association of self-protection with symptom rates was higher before and after pesticide application than during application itself.

DISCUSSION: Training in safe pesticide use had association with symptoms ever during or < 24 hours after pesticide including any system and ever in last year including eye and any system. Subjects who had never been trained in safe pesticide use generally had lower symptom rates than subjects who had been trained. It might be that subjects who had been trained in safe use were at higher risk of pesticide exposure, or that training programs were not especially effective.

Duration of using pesticides as rice farmer had association with symptoms ever during or < 24 hours after pesticide use including respiratory, in accordance with the study of Lu [9] that respiratory symptoms for the past 12 months were associated with certain risk factors such as farm use of pesticides.

Frequency of pesticide use last year had strong association with symptoms including neuromuscular, and any system in accordance with the study of [8]Warisara that acute pesticide poisoning symptoms had significant relationship with neuromuscular, respiratory, digestive and skin.

Duration of each pesticide applying had association with symptoms ever during or < 24 hours after pesticide use including neuromuscular, and any system, that neuromuscular system had association with duration of applying, skin/nails, and any system. There were similar from[8] Warisara that duration of spraying had relationship with neuromuscular system, but there were some different results from[8] Warisara, who found when duration of spraying was high, symptoms were high (categories by 0-1 hour, 2-3 hours, and > 3 hours). But the current study found highest symptoms at the shortest time (1-2 hours) application and decreased after that, then increased again for using more hours (categories by 1-2 hours, 3 hours, 4 hours, and > 4 hours). When categorized duration of applying by two groups (1-2 hours, and > 2 hours) found that duration of applying had association with neuromuscular system (p < 0.001), respiratory system (p = 0.064) and any system (p = 0.001) during or < 24 hours after pesticide use, and consistently found that the shorter duration was associated with higher symptom rates. This suggests that a substantial percentage of subjects (107/420 or 25.5%) were susceptible to developing symptoms after very short exposure to pesticides. They may have stopped applying pesticide quickly, after developing symptoms. Further effort should be made to document sensitive subgroups and to advise them appropriately regarding risks of pesticide use.

The association of self-protection with symptom rates was clearly stronger during pre-application mixing than during application itself, and the association of self-protection with symptom rates was clearly stronger after pesticide application than during application itself. Thus, self-protective behaviors during application were less strongly associated with symptom rates than were such behaviors before and after application. To some extent, the strong associations of symptoms with protective behavior before and after application could reflect confounding. That is, the same group of people might have used better protection both before and after confounding. Indeed, there was a significant positive association of self-protection before and after application (p = 0.023). However, it is unlikely that confounding could fully explain this observation, because self-protection before application was very strongly associated with protection during application (p<0.001), but protection during application was only weakly associated with symptoms. Thus, it seems likely that the observed associations of symptoms with self-protection before and after application are largely separate and independent of each other.

Limitation: This study did not evaluate all types of pesticide, exposure and health effects. Also, the study was done only in one of the nine districts in Sukhothai, so it might not be representative of the whole province, or of larger geographic areas such as Thailand itself. This study did not use multivariable analysis that could more effectively have assessed the relative importance of independent variables in relation to dependent variables.

The research found that pesticide-related such as frequency of pesticide use,

concentration, and duration of each applying had strong association with symptoms. Self-protection behaviors that while mixing and after pesticide use had strong association with symptoms. Thus, the occupational health and health promotion authorities should be concerned about pesticide use and self-protection behaviors and promote a method for rice farmers to reduce chemical exposure and improve chemical management, e.g., integrated pesticide management. Socio-demographic such as age, marital status, education level, income, and trained in safe use had association with symptoms; the related officers should provide participation and co-operation with other while choosing intervention programs or target groups.

ACKNOWLEDGEMENT: Thank the Director, Kongkrailat Health District Office, and all the staffs of health centres in five sub-districts for extending me wholehearted support. We are extremely grateful to rice farmers for their kind support, without their help we would never have been able to accomplish this study.

REFERENCES:

1. Clark, A. 1997. Pesticides use in Thailand.Retrieved Oct 5, 2005. Available from http:// www. sare. org./ htdocs /hypermail/ html-home/18-html/0405.html-8k.

2. Integrated Pest Management [IPM]. (2005).Integrated Pest Management. Reducing the risk. Retrieved Sept 4, 2005. Available from : http://www.Ipmthailand.org/en/ Pesticides /risk_redyctuib.htm.3.

3. World Health Organization [WHO]. (1990).Public health Impact of pesticides used inAgriculture. Geneva.

4. Ministry of Public Health [MOPH]. (2003). Report at meeting National Health for all. Bangkok. The Ministry.

5. Ministry of Public Health [MOPH]. (1998). Thailand Health Profile 1997-1998. Bangkok: The Ministry.

6. Kamel, F., Engel, L.S., Gladen, B.C., Hoppin,J.A.,Alavanja,M.R.,Sandler,D.p.(2005). Neurologic symptoms in licensed private pesticide applicators in the agricultural health study. Environ Health Perspect. 113, 7, 877-82.

7. Yasinn, M M., Mourad, T A Abu., Safi, J M.(2002). Knowledge, attitude, practice, and toxicity symptoms associated with pesticide use among farm workers in the Gaza Strip. Occup Environ Med. 59, 387- 394.

8. Sorat Warisara. (2004). The relationship between health belief, pesticide use and safety behaviors with acute poisoning symptom of farmers,Chaiyaphom Province. Master's Thesis, Faculty of Graduate Studied, Mahidol University.Lu, JL. (2005). Risk factors to pesticide exposure and associated health symptoms among cut-flower farmers. Int J Environ Health Res. 15, 3, 161-9.