CHAPTER IV

RESEARCH RESULTS

This research was a cross-sectional analytical study, which characterized pesticide use and other factors, and evaluated their relationships to symptoms of rice farmers. There were 420 subjects, all of whom lived in Kongkrailat District, Sukhothai Province. Results are presented in 3 parts as follows:

Section 4.1: Descriptive information on the following characteristics:

- Socio-demographic factors (independent variables): gender, age, marital status, education level, member of household, family' monthly income, years lived in Kongkrailat district, and experience with training in safe pesticide use;

- Pesticide use factors (independent variables): frequency of pesticide use, concentration of pesticide used, duration of pesticide use, method of pesticide use, duration since most recent exposure to pesticides, specific role of pesticide use, the number of pesticides mixed for spraying, and duration of working as rice farmer.

- Practice in self-protection (independent variables) including 3 separate periods on days when using pesticides (while mixing pesticides before application, while applying pesticides, and after applying pesticides), and on days when not using pesticides;

- History of pesticide-related symptoms (dependent variables)

Section 4.2: Relationships (associations) between symptoms and independent variables listed above.

Section 4.3: Symptoms persisting after most recent pesticide use.

4.1 Descriptive information

4.1.1 Socio-demographic factors (independent variables)

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 old. 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 7. 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.

Table 7: Number and percentage of subjects by socio-demographic characteristics (n = 420)

Demographic characteristics	Number	Percentage
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, Minimum = 15, Maximum = 73		
Marital status		
Single	54	12.9
Married	349	83.1
Divorced/separated/widowed	17	4.0
Education level		
Illiterate or primary school	340	81.0
Secondary school (grade 7 – 10)	45	10.7
High school /More than 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, Minimum = 1, Maximum = 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, Minimum = 1,250, Maximum = 60,000		

Table 7: Number and percentage of subjects by demographic characteristics (n = 420) (continued)

Demographic characteristics	Number	Percentage
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, Minimum = 2, Maximum = 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

Table 8 summarizes smoking and drinking by gender. From table 8, it was shown that 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 8: Number and percentage of subjects by smoking and drinking (n = 420)

Item	No		Yes	
	N	Percentage	N	Percentage
Smoking				
Male (n=250)	148	59.2	102	40.8
Female (n=170)	168	98.8	2	1.2
Drinking				
Male (n=250)	112	44.8	138	55.2
Female (n=170)	160	94.1	10	5.9

4.1.2 Pesticide use factors

Regarding to pesticide use factors, Most of subjects (75.7%) had work 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 of 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 9.

Table 9: Number and percentage of subjects by pesticide use factors (n = 420)

Pesticide use factors	Number	Percentage
Duration of working as rice farmer (year)		
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, Minimum = 1, Maximum = 60		
Duration of using pesticide as rice farmer (year)		
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, Minimum = 1, Maximum = 54		
Frequency of pesticide use in the last year (day)		
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, Minimum = 2, Maximum = 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, Minimum = 1, Maximum = 10		

Table 9: Number and percentage of subjects by pesticide use factors (n = 420), (continued)

Pesticide use factors	Number	Percentage
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, Minimum = 1, Maximum = 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

4.1.3 Practice in self-protection

Scores were developed for each of the 4 aspects of self-protective behavior described above (3.5.3). Then, 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-protection 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 10.

Table 10: Number and percentage of the subjects by self- protection behaviors in pesticide use (n = 420)

Self- protection behaviors	Number	Percentage
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		

Table 10: Number and percentage of the subjects by self- protection behaviors in pesticide use (n = 420) (continued).

Self- protection behaviors	Number	Percentage
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		

4.1.4 Symptom history (dependent variables)

A total of 32 symptoms was 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. Responses regarding individual symptoms are given in Table 11. 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/nails were itchy skin (19.3%).

Table 11: Number and percentage of the subjects by history of symptoms.

Symptoms	During or within 24 hrs		Within last year		Within last 6 month		Within last month		Within last week	
	N	%	N	%	N	%	N	%	N	%
Neuromuscular										
Dizziness	108	25.7	154	36.7	112	26.7	58	13.8	24	5.7
Headache	67	16.0	132	31.4	89	21.2	43	10.2	16	3.8
Twitching eyelids	7	1.7	13	3.1	9	2.1	4	1.0	1	0.2
Blurred vision	36	8.6	45	10.7	30	7.1	16	3.8	10	2.4
Insomnia	19	4.53	34	8.1	19	4.5	8	1.9	6	1.4
Staggering gait	10	2.4	14	3.3	10	2.4	5	1.2	2	0.5
Seizure	13	3.1	30	7.1	17	4.0	7	1.7	1	0.2
Shaky heart (irregular rhythm)	58	13.8	73	17.4	52	12.4	24	5.7	7	1.7
Exhausted	147	35.0	160	38.1	137	32.6	71	16.9	22	5.2
Sweating	124	29.5	133	31.7	102	24.3	47	11.2	15	3.6
Muscle weakness	76	18.1	85	20.2	65	15.5	19	4.5	11	2.6
Tremor	16	3.8	20	4.8	16	3.8	6	1.4	4	1.0
Muscle cramps	10	2.4	28	6.7	11	2.6	4	1.0	2	0.5
Excessive salivation	5	1.2	7	1.2	2	0.5	0	0.0	0	0.5
Numbness	15	3.6	28	6.7	10	2.4	6	1.4	3	0.7
Eyes										
Burning- Stinging- Itchy eyes	42	10.0	53	12.6	33	7.9	16	3.8	7	1.7
Red eyes	19	4.5	26	6.2	16	3.8	10	2.4	4	1.0
Excessive tearing	23	5.5	32	7.6	20	4.8	8	1.9	1	0.2

Table 11: Number and percentage of the subjects by history of symptoms (n = 420)

(continued)

Symptoms	During or within 24 hrs		Within last year		Within last 6 month		Within last month		Within last week	
	N	%	N	%	N	%	N	%	N	%
Respiratory										
Burning nose	36	8.6	61	14.5	31	7.4	16	3.8	8	1.9
Nose bleed	0	0.0	1	0.2	1	0.2	0	0.0	0	0.0
Runny nose	15	3.6	53	12.6	27	6.4	9	2.1	1	0.2
Dry throat	121	28.8	135	32.1	99	23.6	44	10.5	12	2.9
Sore throat	19	4.5	71	16.9	34	8.1	16	3.8	4	1.0
Cough	18	4.3	78	18.6	49	11.7	18	4.3	3	0.7
Chest pain (tightness burning)	11	2.6	18	4.3	11	2.6	5	1.2	3	0.7
Wheezing	4	1.0	9	2.1	4	1.0	4	1.0	2	0.5
Digestive										
Nausea	36	8.6	65	15.5	33	7.9	13	3.1	5	1.2
Diarrhea	5	1.2	42	10.0	10	2.4	5	1.2	0	0.0
Stomach cramps	3	0.7	10	2.4	2	0.5	1	0.2	1	0.2
Skin/nails										
Skin rash	30	7.1	55	33.1	30	7.1	18	4.3	10	2.4
Itchy skin	42	10.0	81	19.3	40	9.5	19	4.5	9	2.1
Malformed-discolored-loss of nails	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Table 12 gives histories of symptoms of the organ systems. Most subjects (52.9%) had neuromuscular symptoms during or within 24 hours after use pesticides, and 60.2 percent of them had any symptoms during or within 24 hours after use pesticides. Most of subjects had neuromuscular symptoms within last year (62.9%), last six month (52.6%), last month (30.5%), and last week (11.7%).

Table 12: 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 month		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

4.2 Relationship between independent and dependent variables.

4.2.1 Relationship between socio-demographic factors and history of symptoms

Gender had no significant relationship with pesticide-related symptoms when using Chi-square test ($p > 0.10$), as shown in table 13.

Table 13: Relationships between gender and pesticide-related symptoms.

Symptoms	Gender				X^2	P-value
	Male (n=250)		Female (n=170)			
	N	%	N	%		
Ever during or <24 hours after pesticide use						
Neuromuscular	134	53.6	88	51.8	0.14	0.712
Respiratory	78	31.2	64	37.6	1.80	0.170
Digestive	23	9.2	20	11.8	0.72	0.395
Eye	37	14.8	24	14.1	0.04	0.846
Skin/nails	26	10.4	23	13.5	0.96	0.327
Any system	149	59.6	104	61.2	0.11	0.746
Ever within the last year						
Neuromuscular	160	64.0	104	61.2	0.35	0.557
Respiratory	100	40.0	76	44.7	0.92	0.337
Digestive	48	19.2	39	22.9	0.86	0.353
Eye	44	17.6	34	20.0	0.39	0.535
Skin/nails	56	22.4	36	21.2	0.09	0.766
Any system	169	67.6	111	65.3	0.24	0.623

Table 14 shows that the highest symptom rates were usually found in age 35-44 years. Age had significant relationship with any system ever during or < 24 hours after pesticide use ($p = 0.004$).

Table 14: Relationship between age and pesticide-related symptoms.

Symptoms	Age								X^2	P-value
	15-34 (n=93)		35-44 (n=133)		45-54 (n=120)		55-73 (n=74)			
	N	%	N	%	N	%	N	%		
Ever during or <24 hours after pesticide use										
Neuromuscular	41	44.1	81	60.9	65	54.2	35	47.3	7.33	0.062
Respiratory	25	26.9	51	38.3	42	35.0	24	32.4	3.36	0.340
Digestive	8	8.6	20	15.0	10	8.3	5	6.8	5.05	0.168
Eyes	17	18.3	19	14.3	17	14.2	18	10.8	1.90	0.594
Skin/nails	9	9.7	17	12.8	17	14.2	6	8.1	2.16	0.541
Any system	43	46.2	91	68.4	78	65.0	41	55.4	13.19	0.004*
Ever within the last year										
Neuromuscular	55	59.1	91	68.4	76	63.3	42	56.8	3.51	0.320
Respiratory	32	34.4	63	47.4	53	44.2	28	37.8	4.53	0.209
Digestive	18	19.4	30	26.6	27	22.5	12	16.2	1.52	0.677
Eyes	24	25.8	23	17.3	22	18.3	9	12.2	3.38	0.146
Skin/nails	17	18.3	33	24.8	29	24.2	13	17.6	2.54	0.467
Any system	56	60.2	97	72.9	84	70.0	43	58.1	7.13	0.068

The highest percentage of symptoms that found in marital status was married. Regarding to relationship between marital status and pesticide-related symptoms, marital status had significant relationship with ever during or < 24 hours after pesticide use with neuromuscular ($p < 0.001$), respiratory ($p = 0.001$), eyes ($p = 0.025$), and any system ($p < 0.001$) and ever within last year had significant with neuromuscular ($p = 0.007$), respiratory ($p = 0.003$), skin/nails ($p = 0.018$), and any system ($p < 0.001$), in Table 15.

Table 15: Relationship between marital status and pesticide-related symptoms.

Symptoms	Marital status						X^2	P-value
	Single (n=54)		Married (n=394)		Divorced/ Separated/ Widowed (n=17)			
	N	%	N	%	N	%		
Ever during or <24 hours after pesticide use								
Neuromuscular	14	25.9	203	58.2	5	29.4	23.46	<0.001*
Respiratory	6	11.1	131	37.5	5	29.4	14.75	0.001*
Digestive	2	3.7	4	11.7	0	0.0	5.31[a]	0.070
Eyes	2	3.7	58	16.6	1	5.9	7.35[b]	0.025*
Skin/nails	1	1.9	46	13.2	2	11.8	5.82[c]	0.054
Any system	15	27.8	231	66.2	7	41.2	31.49	<0.001*
Ever within the last year								
Neuromuscular	25	46.3	231	66.2	8	47.1	9.82	0.007*
Respiratory	12	22.2	159	45.6	5	29.4	11.60	0.003*
Digestive	7	13.0	77	22.1	3	17.6	2.46[d]	0.292
Eyes	5	9.3	72	20.6	1	5.9	5.89[e]	0.053
Skin/nails	4	7.4	85	24.4	3	17.6	8.04	0.018*
Any system	25	46.3	247	70.8	8	47.1	15.67	<0.001*

[a] 1 cell (16.7%) have expected count less than 5.The minimum expected count is 1.74.
[b] 1 cell (16.7%) have expected count less than 5.The minimum expected count is 2.47.
[c] 1 cell (16.7%) have expected count less than 5.The minimum expected count is 1.98.
[d] 1cell (16.7%) have expected count less than 5.The minimum expected count is 3.52.
[e] 1cell (16.7%) have expected count less than 5.The minimum expected count is 3.16.

Table 16 shows that symptoms were generally lower with higher education level, especially for symptoms during the last year. Relationship between education level and pesticide-related symptoms, found that education level had significant relationship with symptoms ever in last year including neuromuscular ($p = 0.013$) and any system ($p = 0.049$).

Table 16: Relationship between education level and pesticide-related symptoms.

Symptoms	Education level						X^2	P-value
	Primary School (n=340)		Secondary School (n=45)		High School or more (n=35)			
	N	%	N	%	N	%		
Ever during or <24 hours after pesticide use								
Neuromuscular	185	54.4	24	53.3	13	37.1	3.80	0.149
Respiratory	119	35.0	13	28.9	10	28.6	1.13	0.068
Digestive	36	10.6	4	8.9	3	8.6	0.24[a]	0.887
Eyes	53	15.6	4	8.9	4	11.4	1.73	0.421
Skin/nails	41	12.1	3	6.7	5	14.3	1.36[b]	0.503
Any system	209	61.5	27	60.0	17	48.6	2.21	0.332
Ever within the last year								
Neuromuscular	213	62.6	35	77.8	16	45.7	8.70	0.013*
Respiratory	146	42.9	18	40.0	12	34.3	1.05	0.591
Digestive	74	21.8	10	22.2	3	8.6	3.43	0.180
Eyes	67	19.7	6	13.3	5	14.3	1.53	0.465
Skin/nails	75	22.1	10	22.2	7	20.0	0.08	0.960
Any system	225	66.2	36	80.0	19	54.3	6.05	0.049*

[a] 2 cells (33.3%) have expected count less than 5. The minimum expected count is 3.58.
[b] 1 cell (16.7%) have expected count less than 5. The minimum expected count is 4.08.

As shown in table 17 below, there was no consistent association of household size with symptoms.

Table 17: Relationship between household size and pesticide-related symptoms.

Symptoms	Household size								X^2	P-value
	1-2 persons (n=49)		3 persons (n=141)		4 persons (n=138)		5-10 persons (n=92)			
	N	%	N	%	N	%	N	%		
Ever during or <24 hours after pesticide use										
Neuromuscular	25	51.0	76	53.9	72	52.2	49	53.3	0.16	0.984
Respiratory	15	30.6	50	35.5	48	34.8	29	31.5	0.67	0.880
Digestive	5	10.2	17	12.1	12	8.7	9	9.8	0.89	0.829
Eyes	11	22.4	24	17.0	12	8.7	14	15.2	6.99	0.072
Skin/nails	5	10.2	16	11.3	18	13.0	10	10.9	0.43	0.935
Any system	28	57.1	88	62.4	82	59.4	55	59.8	0.52	0.914
Ever within the last year										
Neuromuscular	31	63.3	89	63.1	85	61.6	59	64.1	0.17	0.983
Respiratory	21	42.9	61	43.3	57	41.3	37	40.2	0.25	0.969
Digestive	11	22.4	30	21.3	28	20.3	18	19.6	0.21	0.977
Eyes	14	28.6	27	19.1	17	12.3	20	21.7	7.45	0.059
Skin/nails	12	24.5	25	17.7	34	24.6	21	22.8	2.28	0.517
Any system	32	65.3	94	66.7	92	66.7	62	67.4	0.06	0.996

Table 18 shows that symptom prevalence was generally inversely associated with income. Subjects who had low income had more symptoms than high income, and monthly income had significant relationship with symptoms ever during or < 24 hours after pesticide use with neuromuscular ($p = 0.005$), respiratory ($p = 0.001$), and any system ($p = 0.001$) and symptoms ever in last year with respiratory ($p = 0.001$), skin/nails ($p < 0.001$), and any system ($p = 0.028$).

Table 18: Relationship between families' monthly income and pesticide-related symptoms.

Symptoms	Family' monthly income						X^2	P-value
	1,250 –5,000 (n=190)		5,001 –10,000 (n=120)		>10,000 (n=110)			
	N	%	N	%	N	%		
Ever during or <24 hours after pesticide use								
Neuromuscular	106	55.8	72	60.0	44	40.0	10.41	0.005*
Respiratory	83	43.7	30	25.0	29	26.4	15.16	0.001*
Digestive	21	11.1	13	10.8	9	8.2	0.69	0.708
Eyes	30	15.8	17	14.2	14	12.7	0.54	0.762
Skin/nails	30	15.8	11	9.2	8	7.3	5.92	0.052
Any system	121	63.7	83	69.2	49	44.5	16.25	0.001*
Ever within the last year								
Neuromuscular	126	66.3	77	64.2	61	55.5	3.64	0.162
Respiratory	104	54.7	35	29.2	37	33.6	23.94	0.001*
Digestive	48	25.3	18	15.0	21	19.1	4.96	0.084
Eyes	38	20.0	19	15.8	21	19.1	0.87	0.647
Skin/nails	60	31.6	17	14.2	15	13.6	18.991	<0.001*
Any system	133	70.0	85	70.8	62	56.4	7.14	0.028*

Table 19 shows that subjects who had never been trained in safe pesticide use generally had lower symptom rates than subjects who had been trained. This finding was somewhat unexpected, and was true especially for neuromuscular symptoms and for symptoms in any body system, which exhibited statistically significant or marginally significant associations with training. Conversely, the rate of eye symptoms in the last year was higher in subjects without training than in subjects with training ($p = 0.041$).

Table 19: Relationships between trained in safe pesticide use and pesticide-related symptoms.

Symptoms	Trained in safe pesticide use				X^2	P-value
	Never (n=324)		Ever (n=96)			
	N	%	N	%		
Ever during or <24 hours after pesticide use						
Neuromuscular	163	50.3	59	61.5	3.70	0.055
Respiratory	111	34.3	31	32.3	0.13	0.720
Digestive	29	9.0	14	14.6	2.56	0.110
Eye	51	15.7	10	10.4	1.69	0.193
Skin/nails	37	11.4	12	12.5	0.08	0.772
Any system	186	57.4	67	69.8	4.74	0.029*
Ever within the last year						
Neuromuscular	195	60.2	69	71.9	4.33	0.037*
Respiratory	141	43.5	35	36.5	1.51	0.218
Digestive	68	21.0	19	19.8	0.06	0.800
Eye	67	20.7	11	11.5	4.16	0.041*
Skin/nails	75	23.1	17	17.7	1.28	0.258
Any system	208	64.2	72	75.0	3.89	0.049*

4.2.2 Relationship between pesticide use factors and symptoms.

Table 20 shows that symptoms tended to be low when duration of using pesticide was low. Duration of using pesticides as rice farmer had significant relationship with symptoms ever during or < 24 hours after pesticide use including respiratory ($p = 0.017$), and any system ($p = 0.026$) and symptoms ever in last year including respiratory ($p < 0.001$), and skin/nails ($p < 0.001$).

Table 20: Relationship between duration of using pesticides as rice farmer and pesticide-related symptoms.

Symptoms	Duration of using pesticides as rice farmer						X^2	P-value
	1-9 years (n=105)		10-19 years (n=191)		20-54 years (n=124)			
	N	%	N	%	N	%		
Ever during or <24 hours after pesticide use								
Neuromuscular	48	45.7	104	54.5	70	56.5	2.99	0.225
Respiratory	27	25.7	78	40.8	37	29.8	8.16	0.017*
Digestive	10	9.5	18	9.4	15	12.1	0.66	0.718
Eyes	12	11.4	30	15.7	19	15.3	1.09	0.580
Skin/nails	11	10.5	28	14.7	10	8.1	3.37	0.186
Any system	52	49.5	119	62.3	82	66.1	7.17	0.026*
Ever within the last year								
Neuromuscular	59	56.2	122	63.9	83	66.9	2.97	0.227
Respiratory	32	30.5	100	52.4	44	35.5	16.30	<0.001*
Digestive	15	14.3	46	24.1	26	21.0	3.97	0.138
Eyes	14	13.3	40	20.9	24	19.4	2.67	0.264
Skin/nails	14	13.3	59	30.9	19	15.3	16.66	<0.001*
Any system	62	59.0	129	67.5	89	71.8	4.26	0.119

Table 21 shows that percentage of symptoms was high when frequency of pesticide use in the last year was high. The number of days of pesticide use last year had significant relationship with symptoms ever during or < 24 hours after pesticide use including neuromuscular ($p < 0.001$), and any system ($p < 0.001$) and symptoms ever in last year including neuromuscular ($p < 0.001$), respiratory ($p = 0.010$), digestive ($p = 0.003$), skin/nails ($p < 0.001$), and any system ($p < 0.001$).

Table 21: Relationship between frequency of pesticide use last year and pesticide-related symptoms.

Symptoms	Frequency of pesticide use last year						X^2	P-value
	1-7 days (n=114)		8-14 days (n=210)		15-85 days (n=96)			
	N	%	N	%	N	%		
Ever during or <24 hours after pesticide use								
Neuromuscular	52	45.6	93	44.3	77	80.2	37.41	<0.001*
Respiratory	42	36.8	64	30.5	36	37.5	2.10	0.351
Digestive	8	7.0	22	10.5	13	13.5	2.44	0.295
Eyes	16	14.0	27	12.9	18	18.8	1.87	0.392
Skin/nails	14	12.3	19	9.0	16	16.7	3.77	0.152
Any system	63	55.3	107	51.0	83	86.5	36.29	<0.001*
Ever within the last year								
Neuromuscular	62	54.4	119	56.7	83	86.5	29.85	<0.001*
Respiratory	49	43.0	75	35.7	52	54.2	9.29	0.010*
Digestive	15	13.2	41	19.5	31	32.3	11.98	0.003*
Eyes	19	16.7	40	19.0	19	19.8	0.40	0.819
Skin/nails	21	18.4	34	16.2	37	38.5	20.35	<0.001*
Any system	68	59.6	125	59.5	87	90.6	32.14	<0.001*

Table 22 shows that subjects who mixed pesticides at less than or same as recommended concentrations generally had lower symptom rates than did those who mixed pesticides more than recommended. Concentration had significant relationship with symptoms ever during or < 24 hours after pesticide use including neuromuscular (p =0.011), respiratory (p = 0.011), and any system (p = 0.047) and symptoms ever in last year including neuromuscular (p = 0.047), and any system (p = 0.003).

Table 22: Relationships between concentration and pesticide-related symptoms.

Symptoms	Concentration				X^2	P-value
	Less than or same as recommended (n=334)		More than recommended (n=86)			
	N	%	N	%		
Ever during or <24 hours after pesticide use						
Neuromuscular	166	49.7	56	65.1	6.522	0.011*
Respiratory	103	30.8	39	45.3	6.435	0.011*
Digestive	31	9.3	12	14.0	1.624	0.202
Eyes	46	13.8	15	17.4	0.742	0.389
Skin/nails	37	11.1	12	14.0	0.549	0.459
Any system	187	56.0	66	76.7	3.951	0.047*
Ever within the last year						
Neuromuscular	202	60.5	62	72.1	3.951	0.047*
Respiratory	134	40.1	42	48.8	2.135	0.144
Digestive	69	20.7	18	20.9	0.003	0.956
Eyes	63	18.9	15	17.4	0.091	0.763
Skin/nails	74	22.2	18	20.9	0.060	0.806
Any system	211	63.2	69	80.2	8.956	0.003*

Table 23 summarizes symptom rates by hours per day using pesticides, and shows that symptoms were usually highest at the shortest duration of 1-2 hours, then decreased at 3 hours and rose consistently thereafter. Daily duration of pesticide use had significant relationship with symptoms ever during or < 24 hours after pesticide use including neuromuscular ($p < 0.001$), and any system ($p = 0.004$) and symptoms ever in last year including neuromuscular ($p < 0.001$), skin/nails ($p = 0.023$), and any system ($p < 0.001$).

Table 23: Relationship between daily duration of pesticide use and pesticide-related symptoms.

Symptoms	Duration of each spraying								X^2	P-value
	1-2 hours (n=107)		3 hours (n=136)		4 hours (n=104)		=>5 hours (n=73)			
	N	%	N	%	N	%	N	%		
Ever during or <24 hours after pesticide use										
Neuromuscular	73	68.2	57	41.9	50	48.1	42	57.5	18.27	<0.001*
Respiratory	44	41.1	41	30.1	34	32.7	23	31.5	3.60	0.308
Digestive	11	10.3	13	9.6	12	11.5	7	9.6	0.29	0.961
Eyes	14	13.1	23	16.9	15	14.4	9	12.3	1.09	0.780
Skin/nails	16	15.0	13	9.6	11	10.6	9	12.3	1.86	0.602
Any system	79	73.8	70	51.5	59	56.7	45	61.6	13.21	0.004*
Ever within the last year										
Neuromuscular	84	78.5	71	52.2	57	54.8	52	71.2	22.91	<0.001*
Respiratory	55	51.4	52	38.2	43	41.3	26	35.6	5.92	0.116
Digestive	30	28.0	23	16.9	17	16.3	17	23.3	6.19	0.103
Eyes	18	16.8	28	20.6	19	18.3	13	17.8	0.62	0.893
Skin/nails	34	31.8	24	17.6	17	16.3	17	23.3	9.50	0.023*
Any system	87	81.3	79	58.1	62	59.6	52	71.2	17.84	<0.001*

Table 24 shows that symptoms were generally higher with more methods of application. Method of pesticide use had no significant relationship with symptoms ever in last year. However, it had significant relationship with symptoms ever during or < 24 hours after pesticide use including respiratory (p = 0.004), and any system (p = 0.006).

Table 24: Relationships between method of pesticide use and pesticide-related symptoms.

Symptoms	Method of pesticide				X^2	P-value
	Spraying (n=192)		Spraying and scattering (n=228)			
	N	%	N	%		
Ever during or <24 hours after pesticide use						
Neuromuscular	94	49.0	128	56.1	2.16	0.142
Respiratory	51	26.6	91	39.9	8.30	0.004*
Digestive	19	9.9	24	10.5	0.04	0.832
Eyes	27	14.1	34	14.9	0.06	0.806
Skin/nails	19	9.9	30	13.2	1.08	0.300
Any system	102	53.1	151	66.2	7.47	0.006*
Ever within the last year						
Neuromuscular	118	61.5	146	64.0	0.30	0.586
Respiratory	72	37.5	104	45.6	2.82	0.093
Digestive	44	22.9	43	18.9	1.04	0.307
Eye	37	19.3	41	18.0	0.11	0.735
Skin/nails	45	23.4	47	20.6	0.49	0.486
Any system	122	63.5	158	69.3	1.55	0.213

Table 25 shows that symptom rates generally decreased with increasing number of pesticides mixed. This finding was somewhat unexpected. Specifically, the number of pesticides mixed had statistically significant inverse relationships with symptoms ever during or < 24 hours after pesticide use including respiratory ($p = 0.004$) and symptoms ever in last year including respiratory ($p = 0.001$), and digestive ($p = 0.005$).

Table 25: Relationships between number of pesticide mixed and pesticide-related symptoms.

Symptoms	Number of pesticide mixed				X^2	P-value
	1 or 2 kinds (n=69)		3 kinds or more (n=351)			
	N	%	N	%		
Ever during or <24 hours after pesticide use						
Neuromuscular	38	55.1	184	52.4	0.163	0.687
Respiratory	32	46.4	110	31.3	5.827	0.016*
Digestive	8	11.6	35	10.0	0.165	0.684
Eye	10	14.5	51	14.5	<0.001	0.994
Skin/nails	11	15.9	38	10.8	1.464	0.226
Any system	46	66.7	207	59.0	1.425	0.233
Ever within the last year						
Neuromuscular	49	71.0	215	61.3	2.353	0.125
Respiratory	41	59.4	135	38.5	10.405	0.001*
Digestive	23	33.3	64	18.2	8.005	0.005*
Eye	14	20.3	64	18.2	0.161	0.688
Skin/nails	20	29.0	72	20.5	2.420	0.120
Any system	50	72.5	230	65.5	1.249	0.264

Regarding pesticide-related duties, higher symptom rates were generally observed in subjects who both mixed and applied pesticides than in subjects who had only one of these duties. Main duty in handling had significant relationship with symptoms ever during or < 24 hours after pesticide use including neuromuscular ($p < 0.001$), and any system ($p = 0.001$) and symptoms ever in last year including any system ($p = 0.027$), shown in table 26 below.

Table26: Relationship between main duty in handling and pesticide-related symptoms.

Symptoms	Main duty in handling								X^2	P-value
	Mixing only (n=64)		Applying only (n=41)		Both mixing and applying (n=277)		Any other responsibility (n=38)			
	N	%	N	%	N	%	N	%		
Ever during or <24 hours after pesticide use										
Neuromuscular	26	40.6	17	41.5	167	60.3	12	31.6	19.02	<0.001*
Respiratory	21	32.8	10	24.4	99	35.7	12	31.6	0.20	0.532
Digestive	5	7.8	3	7.3	29	10.5	6	15.8	2.08	0.556
Eyes	9	14.1	6	14.6	41	14.8	5	13.2	0.09	0.993
Skin/nails	7	10.9	4	9.8	30	10.8	8	21.1	3.61	0.306
Any system	34	53.1	17	41.5	185	66.8	17	44.7	16.16	0.001*
Ever within the last year										
Neuromuscular	38	59.4	22	53.7	185	66.8	19	50.0	6.34	0.096
Respiratory	28	43.8	14	34.1	121	43.7	13	34.2	2.39	0.496
Digestive	17	26.6	7	17.1	50	18.1	13	34.2	7.07	0.070
Eyes	12	18.8	9	22.0	49	17.7	8	21.1	0.61	0.895
Skin/nails	11	17.2	8	19.5	62	22.4	11	28.9	2.11	0.550
Any system	41	64.1	22	53.7	197	71.1	20	52.6	9.16	0.027*

4.2.3 Relationship between practice in self-protection and pesticide-related symptoms.

This section describes the analysis of the relation different self-protection behaviors and pesticide related symptoms. There were groups of behaviors that included while mixing (before application), while applying, after applying, on

days when not using pesticides, and a summary metric for all self-protection behaviors combined.

Table 27 shows that low self- protection while mixing pesticides before application was associated with higher symptoms than high self-protection, Self-protection while mixing had significant relationship with all symptoms ever during or < 24 hours after pesticide use including neuromuscular ($p = 0.003$), respiratory ($p < 0.001$), digestive ($p < 0.001$), eye ($p = 0.002$), skin ($p = 0.032$), and any system ($p < 0.001$) and symptoms ever in last year including neuromuscular ($p = 0.004$), respiratory ($p < 0.001$), digestive ($p = 0.009$), eye ($p = 0.001$), skin ($p = 0.025$), and any system ($p < 0.001$).

Table 27: Relationships between self-protection while mixing pesticides before application and pesticide-related symptoms.

Symptoms	Self-protection while mixing pesticides				X^2	P-value
	Low (n=88)		High (n=332)			
	N	%	N	%		
Ever during or <24 hours after pesticide use						
Neuromuscular	59	67.0	163	49.1	8.99	0.003*
Respiratory	47	53.4	95	28.6	19.11	<0.001*
Digestive	18	20.5	25	7.5	12.64	<0.001*
Eye	22	25.0	39	11.7	9.84	0.002*
Skin/nails	16	18.2	33	9.9	4.59	0.032*
Any system	68	77.3	185	55.7	13.48	<0.001*
Ever within the last year						
Neuromuscular	67	76.1	197	59.3	8.41	0.004*
Respiratory	54	64.1	122	36.7	17.32	<0.001*
Digestive	27	30.7	60	18.1	6.73	0.009*
Eye	27	30.7	51	15.4	10.80	0.001*
Skin/nails	27	30.7	65	19.6	5.01	0.025*
Any system	73	83.0	207	62.3	13.29	<0.001*

Table 28 shows that low self-protection while applying pesticides tended to be associated with higher symptoms than high self-protection, it was found that self-protection while applying had significant relationship with symptoms ever during or < 24 hours after pesticide use including neuromuscular (p = 0.008). Overall, the association of self-protection with symptom rates was higher during pre-application mixing than during application itself.

Table28: Relationships between self-protection while applying pesticides and pesticide-related symptoms.

Symptoms	Self-protection while applying pesticides				X^2	P-value
	Low (n=161)		High (n=259)			
	N	%	N	%		
Ever during or <24 hours after pesticide use						
Neuromuscular	79	49.1	143	55.2	1.50	0.220
Respiratory	67	41.6	75	29.0	7.11	0.008*
Digestive	16	9.9	27	10.4	0.03	0.873
Eye	27	16.8	34	13.1	1.06	0.303
Skin/nails	22	13.7	27	10.4	1.01	0.315
Any system	97	60.2	156	60.2	0.00	0.997
Ever within the last year						
Neuromuscular	96	59.6	168	64.9	1.17	0.280
Respiratory	76	47.2	100	38.6	3.01	0.083
Digestive	28	17.4	59	22.8	1.75	0.185
Eye	34	21.1	44	17.0	1.12	0.290
Skin/nails	31	19.3	61	23.6	1.07	0.301
Any system	104	64.6	176	68.0	0.50	0.478

Table 29 shows that low self-protection after pesticide application had higher symptoms than high self-protection. Self-protection after application had significant relationship with symptoms ever during or < 24 hours after pesticide use including respiratory (p = 0.001), skin/nails (p = 0.004), and any system (p = 0.008) and symptoms ever in last year including neuromuscular (p = 0.048), respiratory (p = 0.008), skin (p = 0.036), and any system (p = 0.007). Overall, the association of self-protection with symptom rates was higher after pesticide application than during

application itself. Thus, on days when pesticides were used, self-protective behaviors before and after application were more strongly associated with symptom rates than were such behaviors during application.

Table29: Relationships between self-protection after applying pesticides and pesticide-related symptoms.

Symptoms	Self-protection after applying pesticides				X^2	P-value
	Low (n=33)		High (n=387)			
	N	%	N	%		
Ever during or <24 hours after pesticide use						
Neuromuscular	22	66.7	200	51.7	2.74	0.098
Respiratory	20	60.6	122	31.5	11.49	0.001*
Digestive	8	24.2	35	9.0	7.64	0.006
Eye	8	24.2	53	13.7	2.72	0.099
Skin/nails	9	27.3	40	10.3	8.46	0.004*
Any system	27	81.8	226	58.4	6.96	0.008*
Ever within the last year						
Neuromuscular	26	78.8	238	61.5	3.89	0.048*
Respiratory	21	63.6	155	40.1	6.95	0.008*
Digestive	11	33.3	76	19.6	3.47	0.062
Eye	10	30.3	68	17.6	3.26	0.071
Skin/nails	12	36.4	80	20.7	4.38	0.036*
Any system	29	87.9	251	64.9	7.25	0.007*

Table 30 shows that low self- protection on the days when not using pesticides had higher symptoms than high self-protection. Such self-protection had significant relationships with symptoms ever during or < 24 hours after pesticide use including

neuromuscular ($p < 0.001$), and any system ($p < 0.001$) and symptoms ever in last year including neuromuscular ($p = 0.005$) and any system ($p < 0.001$).

Table 30: Relationships between self-protection on the days when not using pesticides and pesticide-related symptoms.

Symptoms	Self-protection on the days when not using pesticides				X^2	P-value
	Low (n=87)		High (n=333)			
	N	%	N	%		
Ever during or <24 hours after pesticide use						
Neuromuscular	61	70.1	161	48.3	13.11	<0.001*
Respiratory	32	36.8	110	33.0	0.43	0.510
Digestive	11	12.6	32	9.6	0.69	0.406
Eye	15	17.2	46	13.8	0.65	0.419
Skin/nails	13	14.9	36	10.8	1.14	0.285
Any system	69	79.3	184	55.3	16.66	<0.001*
Ever within the last year						
Neuromuscular	66	75.9	198	59.5	7.95	0.005*
Respiratory	39	44.8	137	41.1	0.38	0.535
Digestive	14	16.1	73	21.9	1.43	0.232
Eye	15	17.2	63	18.9	0.13	0.720
Skin/nails	17	19.5	75	22.5	0.36	0.549
Any system	72	82.8	208	62.5	12.79	<0.001*

4.3 Persistent symptoms and illness after most recent pesticide use

Table 31 shows that 140 subjects (33.3%) had no symptoms within last year, and 280 subjects (66.7%) of them had any symptoms. Interestingly, 15.0% of subjects who had any symptoms in last year had persistent symptoms after their most recent reported pesticide use. Within individual systems, there were 14.0% of neuromuscular, 10.8% of respiratory, 4.6% of eyes, 6.4% of digestive, and 4.3% of skin/nails had persistent symptoms after their most recent pesticide use. Thus, a substantial percentage of subjects with symptoms continued to have them even after pesticide use stopped. To the best of my knowledge, this is Thailand's first assessment of persistent symptoms after stopping pesticide use.

Table 31: Number and percentage of persistent symptoms after most recent pesticide use.

Symptoms	Without symptoms in last year		Have symptoms in last year		Symptoms after most recent pesticide use	
	N	%	N	%	N	%*
Neuromuscular	156	37.1	264	62.9	37	14.0
Respiratory	244	58.1	176	41.9	19	10.8
Digestive	333	79.3	87	20.7	4	4.6
Eyes	342	81.4	78	18.6	5	6.4
Skin/nails	328	78.1	92	21.9	4	4.3
Any system	140	33.3	280	66.7	42	15.0

* The denominator for this percentage is the number of subjects with symptoms of the designated organ system, not the total number of 420 subjects.