CHAPTER 4

RESULTS AND DISCUSSION

4.1 Pesticide Exposure Questionnaire Information

4.1.1 General Information

Samples from the pesticide exposure questionnaire were obtained from 73 persons with their general information. The results were interpreted through both statistical tables and descriptive statistics. All information relevant to the number and the percentage of the respondents are shown as follows:

According to Table 4.1.1, the samples were 33 Traditional farmers or 45.2% and 40 IPM farmers or 54.8% which consisted of 38 males and 35 females. 57.8% or 42 persons were in the age range of 36 – 55 years old. The second largest group was 29 – 35 years old or 19 people (26%). The result showed that the mean of the farmer was 42.59 years old while the mode was 35 and 48 years old (n =5).

The largest samples or 34.2% lived in Moo 10 (Village No. 10), and the second largest group (17.8%) lived in Moo 5. It was quite obvious that IPM and Traditional farmers in Tambon Bang Rieng lived separately to each other. Most of IPM farmers were local people who lived in Moo 3, 4, 5, and 8, respectively, while Traditional farmers were from other provinces and settle down in Moo 10 and 11.

As for their educational background levels, 50% of the samples graduated from the first primary school (Grade 1-4) and 32.9% graduated from the second part of primary school (Grade 5-6)

One third of these samples representing 25 farmers were vegetable farmers for 1-5 years and 30.1% for 6 –10 years. Most of samples or 86.4% had members in their families who worked as farmers. 79.5% or 58 peoples said that their

children were more than 5 years old while 17.8% had a child less than 5 years old. There were two persons out of 73 said that they had two children less than 5 years old.

There were 39 persons representing 53.4% who hadtheir house located in the farm area, while 26% resided around their farm areas. The remainders, 20.5%, lived outside the farm areas. To this point, it can be noted that some farmers, who were the land owned often, located their house in the farms. On the other hand, there were very few farmers who located their house outside the farm areas. For the farming size, most of them (87.7%) farm the land less than five rais (two acres).

The average time for applying pesticide in their farm for a month was asked. According to the results, 21.9% of the samples applied four times a month and the same percentage of 21.9% applied three times a month. In addition, 20.5% applied once a month, 15.1% applied two times, 9.6% applied five times, 6.9% applied more than five times a month and only 4.2% or three samples applied less than once a month respectively.

For the average time for applying pesticide in their farms in one month, the number of spraying were moderately high because most of farmers always applied herbicide such as paraquart-dichloride, glyphosate isopropyl and alachor, to control grasses and weed. Moreover, most of farmers misunderstood the definition of "pesticide". To their understandings, "pesticide" only means the insecticide, which does not include herbicide and fungicide. They also thought that herbicide and fungicide have lower toxic and hazard than insecticide.

Most of the farmers or 69.9% worked in their farms for 8 hours and 80.9% had annually worked and cultivated their farms for 240 - 300 days or approximately 8 - 10 months. It could be said that they worked in their farm thoughout the year, except only in heavy rainy season during November – December.

TABLE 4.1.1: General Information

General Information	Number of Persons	Percentage
1. Farmer Group		
- Traditional Farmer	33	45.2
- IPM Farmer	40	54.8
Total	**73**	**100.0**
2. Gender		
- Male	38	52.1
- Female	35	47.9
Total	**73**	**100.0**
3. Age		
- Less than 25 yrs. old	3	4.1
- Between 26 – 35 yrs. old	19	26.0
- Between 36 – 45 yrs. old	21	28.8
- Between 46 – 55 yrs. old	21	28.8
- More than 56 yr. old	9	12.3
Total	**73**	**100.0**
4. Address (Village Number)		
- Moo 1	1	1.4
- Moo 3	10	13.7
- Moo 4	4	5.5
- Moo 5	13	17.8
- Moo 6	5	6.8
- Moo 8	6	8.2
- Moo 10	25	34.2
- Moo 11	9	12.3
Total	**73**	**100.0**
5. Education Background		
- Uneducated	4	5.5
- First Primary School (Grade 1 - 4)	36	49.3
- Second Primary School (Grade 5 - 6)	24	32.9
- Junior High School (Grade 7 - 9)	5	6.8
- Senior High School (Grade 10 – 12)	4	5.5
Total	**73**	**100.0**
6. Duration of farming		
- Less than 1 yr.	6	8.2
- Between 1 - 5 yrs.	25	34.2
- Between 6 - 10 yrs.	22	30.1
- Between 11 -15 yrs.	5	6.8
- Between 16 - 20 yrs.	8	11.0
- More than 20 yrs.	7	9.6
Total	**73**	**100.0**

TABLE 4.1.1: General Information (con't)

General Information	Number of Persons	Percentage
7. Family members who would as the farmers		
- 1 person	8	11.0
- 2 persons	38	52.1
- 3 persons	17	23.3
- 4 persons	4	5.5
- 5 persons	5	6.8
- 6 persons	1	1.4
Total	**73**	**100.0**
8. Number of children (Age less than 5 yrs. old)		
- 0 person	58	79.5
- 1 person	13	17.8
- 2 persons	2	2.7
Total	**73**	100.0
9. Whether the farmers bring their children to farm or not?		
- Yes	14	93.3
- No	1	6.7
Total	**15**	**100.0**
10. House Location		
- In the farm area	39	53.4
- Around the farm area	19	26.0
- Out of the farm area	15	20.5
Total	**73**	**100.0**
11. Number of farm area		
- Less than 5 rais (2 acres)	64	87.7
- More than 5 rais	9	12.3
Total	**73**	**100.0**
12. Average time for applying pesticide for a month		
- Less than 1 time	3	4.2
- 1 time	15	20.5
- 2 times	11	15.1
- 3 times	16	21.9
- 4 times	16	21.9
- 5 times	7	9.6
- More than 5 times	5	6.9
Total	**73**	**100.0**

TABLE 4.1.1: General Information (con't)

General Information	Number of Persons	Percentage
13. Daily Working hour in the farms		
- Less than 8 hrs.	20	27.4
- 8 hrs.	51	69.9
- More than 8 hrs.	2	2.8
Total	**73**	**100.0**
14. Number of annual growing period		
- Less than 240 days	3	4.2
- 270 days	16	21.9
- 300 days	40	54.8
- 330 days	5	6.8
- 360 days	9	12.3
Total	**73**	**100.0**

The samples were requested to name the pesticide, which they applied in last three months. From 163 answers, the researcher categorized into 5 groups. According to the result (Figure 4.1), 29.45% of the samples told that they used herbicide such as alachor, paraquart-dichloride, glyphosate isopropyl. While 23.93% told that they applied organophosphate pesticide such as methyl parathion, chlorpyrifos, propynofos, etc., and 1.84% applied fungicide (carbendazim), however, the largest group representing 38.04% used other insecticide such as methomil, abacmectin, cypermectin and chlorfenaphor, and etc.

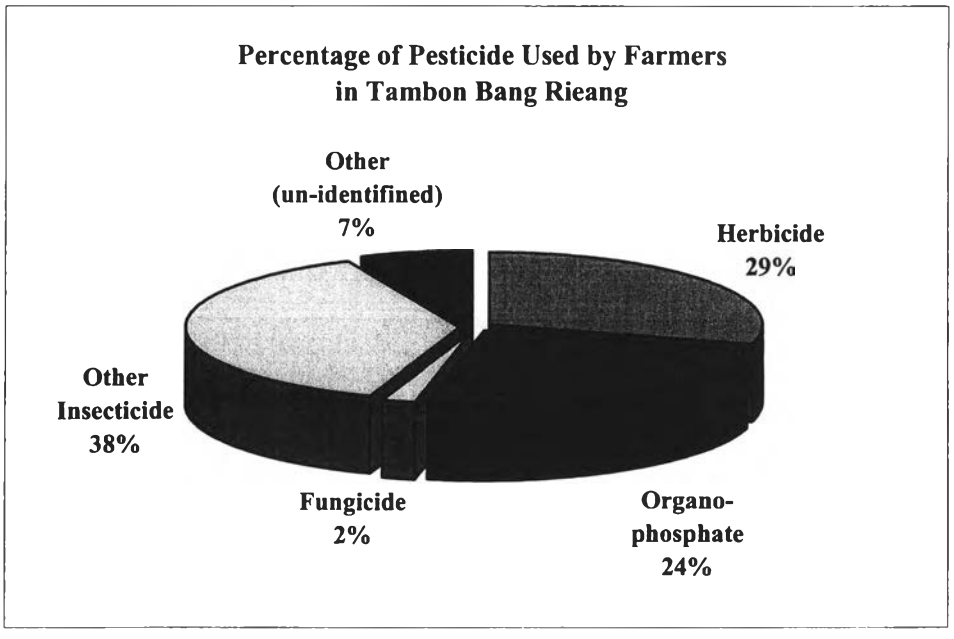

Figure 4.1 : Percentage of Pesticide Used by Farmers in Tambon Bang Rieng between Nov. 2002 – Feb. 2003

According to Table 4.1.2, most of the samples (68.5%) have never conducted blood testing to determine the safety level (cholinesterase activities) of the organophosphate pesticide exposure, while 31.5% were used to have blood testing. However, it has been found that 20 farmers had cholinesterase activities in the normal level, while one farmer had lower cholinesterase activities level but in a safe level. There were two farmers who had the lowest cholinesterase activities level, which were at risk to pesticide exposure.

4.1.2 Health Information

The researcher evaluated health effect of the farmers after applying and being exposed to pesticides by assigning the scores for each effect (depending on its severity and frequency). The maximum and minimum scores of the health effect equaled 35 points and 0 point respectively. The highest score from the interview was 10 point and its details were shown in the Table 4.1.2

Public Health Center in Tambon Bang Rieng has set the annual plan for the Cholinesterase Activity Test to determine whether any farmers are exposed to organophosphate and carbamate pesticide. However, the researcher found that only few farmer had received the test because they were afraid to know the blood testing result which would upset them.

TABLE 4.1.2: Health Information

General Information	Number of Persons	Percentage
1. Blood testing result		
- Normal	20	27.4
- Safe	1	1.4
- Risk	2	2.7
- None	50	68.5
Total	**73**	**100.0**
2. Health effect's scores from pesticide exposure		
- 0 point	54	74.0
- 1 point	5	6.8
- 2 point	6	8.2
- 3 point	1	1.4
- 4 point	3	4.1
- 5 point	2	2.7
- 6 point	1	1.4
- 10 point	1	1.4
Total	**73**	**100.0**

4.1.3 Pesticide Exposure Assessment Scores

The result of the pesticide exposure questionnaire from the Traditional and IPM Farmer were described in the mode of each item as follows:

TABLE 4.1.3:Results and Description of Question in the Pesticide Exposure Assessment Questionnaire (Numbers of samples = 73)

Item	Number of Answers	Description
1. Where do you mix pesticide?	28	In the farm and near the water source
2. What is the method that you select to apply pesticide?	50	Mixed with the individual creation
3. How do you mix the pesticide?	46	Bare hand and use stirring stick
4. When mixing or applying pesticides, which part of your body usually contact the pesticide?	59	Hand and arm
5. When do you spray pesticides?	58	Evening
6. What equipment do you use for spraying pesticides?	35	Hand pump
7. If you spill some of pesticide on your clothes, when do you change clothes?	56	Change after finishing spraying
8. If your last pesticide application is ineffective, what will you do with the firth pest control?	38	Change the new one
9. After applying pesticides, when do you usually change into clean clothes?	64	Immediately
10. How do you wash your clothes, which you wore during applying pesticide?	64	Separate from family washed
11. After mixing and applying pesticides, where do you usually wash up or shower?	48	Bathroom at home
12. What is the method in disposing the pesticides container?	26	To dispose in the ground
13. How do you wash the pesticide equipment after used?	27	Frequently
14. What is the method for washing the pesticide equipment?	36	Rinse all equipment
15. Do you usually repair your own spraying or mixing equipment?	40	No
16. Where do you store the pesticides?	30	In the separate storage facility
17. Where is the source of the water used?	61	Artesian well or deep well

TABLE 4.1.3: Results and Description of Question in the Pesticide Exposure Assessment Questionnaire (Numbers of samples = 73) (con't)

Item	Number of Persons	Description
18. Normally, what kind of drinking water do you usually drink?	54	Artesian well (directly)
19. Whether the water source used for consuming is the same source for mixing pesticides?	39	Different source from farming
20. How far is your usage well from the nearest area where pesticides are mixed?	45	Less than 10 m.
21. Where do you have launch?	64	At home (out of the farm areas
22. Do you drink in the farm or during launch?	67	No

From the results it can be noted that:

1. Farmer did not dispose the pesticide containers properly. For example, they left the containers on the ground, disposed in the dipping holes, threw away and sometimes dropped in the water sources. Consequently, residues were left in the environmental problems.
2. For the question whether the farmers washed the pesticide equipment after using or not, most farmers told that they definitely cleaned their equipment after they applied paraquart-dichloride. The reason was that they beleived the residues of herbicide in the equipment would effect their vegetables.
3. As for the water source (surface water and groundwater) for farming and consuming, Bang Rieng community faced the health effects from being exposed to pesticide residue in drinking water. since local people drank directly from that water source. Moreover, the disposal of pesticide containing was not handled properly, and the ground water in Tambon Bang Rieng was moderately high (~5 m.).
4. Since Tambon Bang Rieng was known as agricultural area, a lot of related field researches were conducted here. Furthermore, local people were friendly and welcomed all researchers. As a result, the positive bias would be occurred because they knew how to answer the questions to impress the researchers. This may cause an error result to the researches.

For the question of wearing of Personal Protective Devices item, the scores were calculated from the PPD wearing in each farmer. The full score (12 points) mean that farmers did not wear any necessary PPD such as, long pant and long sleeve shirt, rubber boots and gloves, goggles and chemical protective mask and that farmer were more exposed to pesticide. In the other hand, if the farmers woar all of the necessary PPD, they would get the fewer score down to zero.

After the questionnaire was calculated, the result showed that 23 farmers had the score more than 6 points (more exposed to pesticide). None of them got the 0 point because no one wore goggle or glasses and chemical protective mask for protecting their eyes and inhalation system. The details are shown in the Table 4.1.4

TABLE 4.1.4: Wearing PPD Scores

Wearing PPD Score	Number of Persons	Percentage
- 0 point (Wear all of necessary PPD)	0	0.0
- 1 point	1	1.4
- 2 points	6	8.2
- 3 points	8	11.0
- 4 points	11	15.1
- 5 points	18	24.7
- 6 points	6	8.2
- 7 points	9	12.3
- 8 points	2	2.7
- 9 points	4	5.5
- 10 points	3	4.1
- 11 points	2	2.7
- 12 points (Don't wear any PPD)	3	4.1
Total	**73**	**100.0**

Pesticide Exposure Scores

After assigning the ordinal (rank) score for each pesticide exposure item, the maximum score from the questionnaire was 92 points and the minimum score was 22 points. However, the highest exposure score was 83 points and the lowest score was 36 points, while the mean scores were 55.67 and their standard deviations were 8.6. The numbers of person in each score is shown in the Figure 4.2

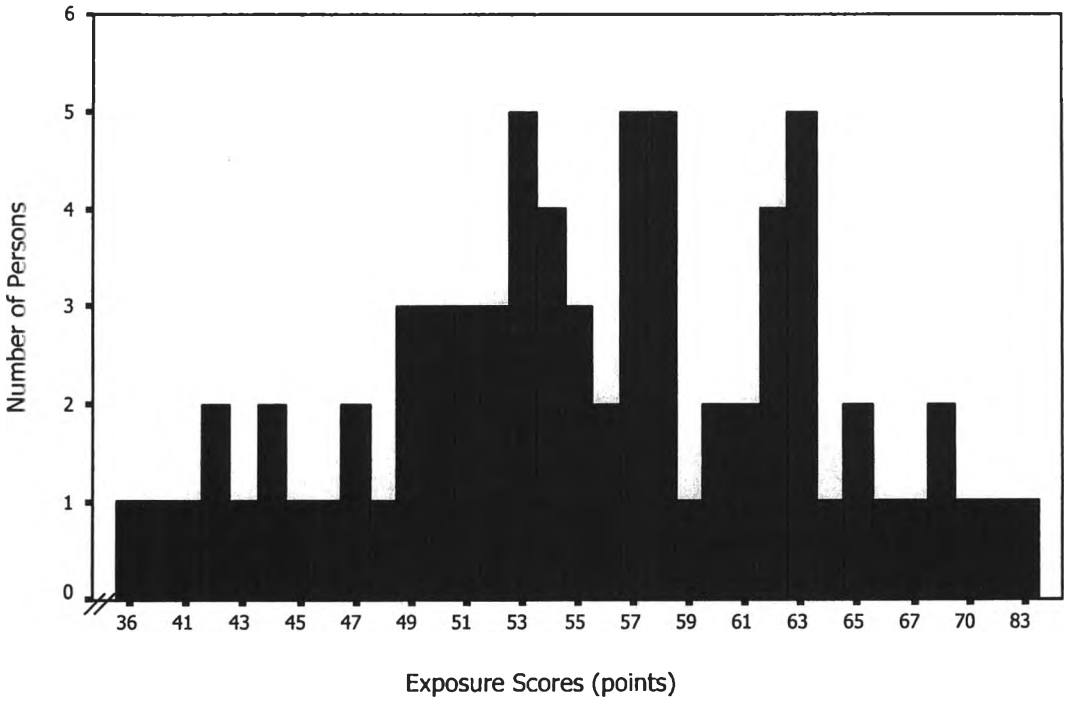

Figure 4.2: Pesticide Exposure Scores of Bang Rieng Farmers

The researcher assigned and calculated the pesticide exposure score into 5 levels by categorizing their scores in the following standard:

Level	Exposure Score (points)	Description
1	22 - 36	Low Exposure
2	36 – 50	Moderately Low Exposure
3	50 – 64	Medium Exposure
4	64 – 78	Moderately High Exposure
5	78 - 92	High Exposure

According to Table 4.15, the results showed that 45 of Bang Rieng farmers had medium pesticide exposure, and 18 farmer had moderately low exposure, while 9 farmer had moderately high and high exposure respectively. The levels of pesticide exposure of Bang Rieng farmers were shown as follow.

TABLE 4.1.5: Pesticide Exposure Level of Bang Rieng Farmers

Exposure Level	Number of persons	Percentage
Low Exposure	1	1.4
Moderately Low Exposure	18	24.7
Medium Exposure	45	61.6
Moderately High Exposure	8	11.0
High Exposure	1	1.4
Total	**73**	**100.0**

4.1.4 IPM Farmer Information

For the IPM farmer, the researcher interviewed the background information about IPM experiences, other method for pest controlling and the time in applying the pesticide. The results showed that 18 farmers worked as IPM farmers for only 0 – 3 year while 14 farmers worked for 5 –10 years.

IPM farmers were requested to tell other methods for pest control except the applied pesticide, and they could answer more than one choice. The results from 54 answers showed that 23 farmers used the natural control and 11 farmers used bio-substances such as margosa juice, Bacteria GM-1. These results were contradicted to Robson et al. study, which questioned 30 IPM farmers in New Jersey. They found that 63.33% or 19 farmers were applied pesticides with mechanical & cultural and biological techniques while nine farmers applied pesticides with mechanical and cultural techniques.

The last question asked about the decision criteria to apply the pesticide, the answer from 35 farmers depicted that 27 farmers applied the pesticide as soon as

they found the worm in their farms while 8 farmers said that they would wait until worm-spreading became serious. These results were contradicted from Robson et al. study, which found that IPM farmers applied pesticide when pest population warranted it.

It can be noted that IPM farmers mainly applied pesticide and hardly use other methods to control pest since they viewed that the most effective method to control pest was spraying pesticide.

IPM farmer information is shown in the Table 4.1.6

TABLE 4.1.6: IPM Farmer Information

IPM Information	Number of Persons	Percentage
1. IPM Period		
- Less than 3 yrs.	18	45.0
- Between 3 – 5 yrs.	6	15.0
- Between 5 –10 yrs.	14	35.0
- No Answer	2	5.0
Total	**40**	**100.0**
2. Except the apply pesticide, What method did the IPM farmers use for pest control? (From 54 answers)		
- Use the bio substances	11	20.4
- Use the bio-control	0	0
- Grow some plants which protect themselves for pest	1	1.8
- Crop rotation	9	16.7
- Grow in the net	6	11.1
- Multi-various techniques	0	0
- None, Use natural control	23	42.6
- Others	4	7.4
Total	**54**	**100.0**
3. When did the farmers decide to apply the pesticide (from 35 farmers)		
- At first sight the pest in the farm	27	88.6
- When the pest population warrantee it	8	11.4
- Follow the schedule plan	0	-
Total	**35**	**100.0**

4.2 Organophosphate Pesticide Concentration in Working Air Condition Study

In this study, the researcher collected 33 air samples from both Traditional (18 samples) and IPM (15 samples) farmers who were 28 male and 5 female The largest samples of 18 farmers lived in Moo 10, and the second largest group of 6 farmers lived in Moo 5.

As for a gender factor, there were many female farmers, especially in IPM group. However, they avoided applying pesticide and assigned this job to her husbands. Few of female farmers applied pesticides by themselves since they were still single and were the only one farmer in their families.

Most farmers of 69.7% applied chlorpyrifos in their farms, while 21.2% farmers applied methyl parathion. However, 3 farmers applied both chlorpyrifos and methyl parathion simultaneously. The reason of using chlorpyrifos was to eradicate worm and using methyl parathion to control ant. However, during the air sampling collection (Nov. 2002 – Feb 2003), the farmers used a high level of chloryrifos since it accidentally was the worm-spreading period.

For the question of "How do the farmer mix and apply the pesticide?", Most farmers always told that they had good practice to apply pesticide. For example, they followed the instruction manual to mix and spray pesticide. However, from the researcher's observation, most of them usually applied more than one type of pesticide simultaneously. For instance, they mixed chlorpyrifos with methyl parathion, or chlorpyrifos with carbendazim and propenofos, etc. consequently, the researcher investigated the number of pesticides type that farmers simultaneously applied. The results showed that only 10 farmers representing 30.3% applied only one pesticide, while 36.4% applied two types simultaneously, 36.4% applied three types and 6.1% applied four types of pesticide respectively.

The general information of the pesticide concentration in working air condition is shown in the Table 4.2.1.

TABLE 4.2.1: General Information of the Pesticide Concentration in Working Air Condition Study

General Information	Number of Persons	Percentage
1. Farmer Group		
- Traditional Farmer	18	54.5
- IPM Farmer	15	45.5
Total	**33**	**100.0**
2. Gender		
- Male	27	81.8
- Female	6	18.2
Total	**33**	**100.0**
3. Address (Village Number)		
- Moo 1	1	3.0
- Moo 3	5	15.2
- Moo 5	6	18.2
- Moo 8	2	6.1
- Moo 10	18	54.5
- Moo 11	1	3.0
Total	**33**	**100.0**
4. Use Pesticide Type		
- Chlorpyrifos	23	69.7
- Methyl parathion	7	21.2
- Both chlorpyrifos & methyl parathion	3	9.1
Total	**33**	**100.0**
5. Spraying Equipment		
- Motor Pump	16	48.5
- Hand Pump	14	42.4
- Portable Motor	3	9.1
Total	**33**	**100.0**
6. Number of Pesticide farmers simultaneously apply		
- 1 type	10	30.3
- 2 types	12	36.4
- 3 types	9	27.3
- 4 types	2	6.1
Total	**33**	**100.0**

Table 4.2.2 showed the number of Traditional and IPM farmers, which was categorized by their genders. The largest group of 48.5% was male-Traditional farmers, 33.3% was male-IPM, 12.1% was female-IPM and the lowest group was female Traditional farmers respectively.

TABLE 4.2.2: Number of Traditional and IPM Farmers

Group / Gender	Traditional Farmer		IPM Farmer		Total	
	No. of persons	percentage	No. of persons	percentage	No. of persons	percentage
Male	16	48.5	11	33.3	**27**	**81.8**
Female	2	6.1	4	12.1	**6**	**18.2**
Total	**18**	**54.6**	**15**	**45.4**	**33**	**100.0**

For the usage of pesticide concentration, the researcher interviewed farmers about the ratio between pesticide and water used while they were mixing the solution. The researcher observed that farmers roughly mixed the pesticides and then approximately determined only concentration of organophosphate pesticide. Details of the concentration were shown in Table 4.2.3. Those farmers applied the pesticide concentration approximately between 0.00016 – 0.00133 mg/m^3. It can be noted the highest concentration was 8 times more than the lowest concentration. Moreover, if considering the total concentration, which more than 1 type of pesticide farmers applied, it can be concluded that farmers applied pesticide in the higher concentration than the recommended concentration, which was 0.0004 – 0.0005 mg/m^3.

TABLE 4.2.3: Approximate Pesticide Concentration Solution which Mixing by Farmers

Name	Number of Samples	Highest Conc.(mg/m^3)	Lowest Conc. (mg/m^3)	Mean Conc. (mg/m^3)
1. Chlorpyrifos	23	0.00133	0.00029	0.00073
2. Methyl parathion	7	0.00125	0.00016	0.00063
3. Both (chlorpyrifos & methyl parathion)	3	0.00117	0.00108	0.00116
Total	**33**	**0.00133**	**0.00016**	**0.00075**

Table 4.2.4 depicted the organophosphate pesticide concentration in the working air condition for each sample. Table 4.2.5 also showed the highest, lowest, mean of pesticide concentration and its standard deviation that farmer exposed, which were 0.6055, 0.0040, 0.1186 and 0.1576 mg/m^3 respectively.

TABLE 4.2.4: Pesticide Concentration in the Working Air Condition

Samples No.	Village No. (Moo)	Farmer Group	Pesticide Name	Number of Pesticide	Solution Concentration* mg/m^3	Spraying Equipment	Pesticide Conc. in air mg/m^3
1	10	Traditional	chlorpyrifos	1	0.00100	Hand Pump	0.1162
2	10	Traditional	methyl parathion	1	0.00125	Hand Pump	0.0168
3	10	IPM	chlorpyrifos	1	0.00060	Motor Pump	0.0831
4	10	IPM	methyl parathion	1	0.00075	Motor Pump	0.0133
5	10	Traditional	chlorpyrifos	2	0.00060	Motor Pump	0.6055
6	10	Traditional	methyl parathion	2	0.00075	Motor Pump	0.0695
7	1	Traditional	methyl parathion	4	0.00050	Motor Pump	0.0438
8	10	Traditional	chlorpyrifos	3	0.00050	Motor Pump	0.4225
9	10	Traditional	chlorpyrifos	2	0.00067	Motor Pump	0.4978
10	10	Traditional	chlorpyrifos	3	0.00067	Motor Pump	0.1284
11	10	Traditional	chlorpyrifos & methyl parathion	3	0.00117	Motor Pump	0.1222
12	10	Traditional	chlorpyrifos	4	0.00100	Motor Pump	0.0137
13	5	IPM	methyl parathion	1	0.00050	Hand Pump	0.0840
14	10	Traditional	chlorpyrifos	3	0.00080	Motor Pump	0.1885
15	10	Traditional	chlorpyrifos	2	0.00060	Motor Pump	0.2517
16	10	Traditional	chlorpyrifos	3	0.00100	Motor Pump	0.1013
17	10	Traditional	chlorpyrifos	3	0.00053	Motor Pump	0.0494
18	10	Traditional	chlorpyrifos	2	0.00040	Motor Pump	0.0307
19	10	Traditional	chlorpyrifos	2	0.00029	Portable Motor	0.0775
20	10	Traditional	chlorpyrifos	3	0.00057	Portable Motor	0.0539

TABLE 4.2.4: Pesticide Concentration in the Working Air Condition (con't)

Samples No.	Village No. (Moo)	Farmer Group	Pesticide Name	Number of Pesticide	Solution Concentration* mg/m^3	Spraying Equipment	Pesticide Conc. in air mg/m^3
21	11	Traditional	chlorpyrifos	1	0.00086	Portable Motor	0.0539
22	3	IPM	chlorpyrifos	1	0.00125	Hand Pump	0.0204
23	3	IPM	methyl parathion	2	0.00050	Hand Pump	0.0040
24	5	IPM	chlorpyrifos	2	0.00067	Hand Pump	0.0429
25	5	IPM	chlorpyrifos	3	0.00089	Hand Pump	0.0462
26	5	IPM	chlorpyrifos	2	0.00089	Hand Pump	0.0587
27	5	IPM	chlorpyrifos	1	0.00067	Hand Pump	0.1324
28	5	IPM	chlorpyrifos	1	0.00133	Hand Pump	0.0216
29	8	IPM	chlorpyrifos	1	0.00033	Hand Pump	0.0238
30	8	IPM	methyl parathion	3	0.00016	Hand Pump	0.0042
31	3	IPM	chlorpyrifos & methyl parathion	2	0.00108	Hand Pump	0.0094
32	3	IPM	chlorpyrifos & methyl parathion	2	0.00122	Hand Pump	0.0257
33	3	IPM	chlorpyrifos	2	0.00060	Motor Pump	0.0559

Note: Solution Concentration calculated only the organophosphate Pesticide from the mixing of farmer and base on the concentration of chlorpyrifos as 40% and methyl parathion as 50% W/V.

TABLE 4.2.5:Organophosphate Pesticide Concentration in Working Air Condition

Pesticide Name	Number of Samples	Highest Conc. (mg/m^3)	Lowest Conc. (mg/m^3)	Mean Conc. (mg/m^3)	S.D.
1. Chlorpyrifos	23	0.6055	0.0204	0.1558	0.1753
2. Methyl parathion	7	0.0696	0.0040	0.0236	0.0242
3. Both (chlorpyrifos & methyl parathion)	3	0.1284	0.0094	0.0545	0.0645
Total	**33**	**0.6055**	**0.0040**	**0.1186**	**0.1576**

The researcher considered and compared the organophosphate pesticide concentration based on ACGIH (TLV-TWA) Recommend (chlorpyrifos and methyl parathion: 0.2 mg/m^3; from NIOSH Method). The results (Table 4.2.6) showed that 15.2% or 5 persons had pesticide exposure over this recommendation. In comparing with ACGIH (STEL) Recommend (chlorpyrifos and methyl parathion: 0.6 mg/m^3), there was only one farmer, who was exposed over the recommendation.

TABLE 4.2.6: Exposure Concentration Compared to ACGIH Recommendation

General Information	Number of Persons	Percentage
Exposure Concentration over the ACGIH (TWA) Recommendation		
- No	29	87.9
- Yes	4	12.1
Total	**33**	**100.0**
Exposure Concentration over the ACGIH (STEL) Recommendation		
- No	32	97.0
- Yes	1	3.0
Total	**33**	**100.0**

4.3 Statistical Analysis

4.3.1 Pesticide Exposure Scores Compared to Traditional and IPM Farmers

The result of mean testing of pesticide exposure score showed that there were significant differences of pesticide exposure scores between Traditional and IPM farmer, while the Traditional farmer (mean = 58.30) had higher exposure score than IPM farmer (mean = 53.50) at the level of .05.

Table 4.3.1 showed information on mean and standard deviation of the pesticide exposure score according to the farmer group.

TABLE 4.3.1: Comparison of Pesticide Exposure Scores between Traditional and IPM Farmers

Farmer Group	N	Mean	S.D.	t	Sig. (2-tailed)
Traditional Farmer	33	58.303	7.477	2.460	**0.016**
IPM Farmer	40	53.500	8.921		

4.3.2 Pesticide Exposure Scores Compared to the Differences in House Locations

Table 4.3.2 - 4 showed the testing results of the pesticide exposure scores when compared to their different house location with ANOVA. It revealed that there were significant differences between pesticide exposure scores and their different house location at the level .05. Then the researcher tested Multiple Comparison method by using the Least Significant Difference (LSD). The result revealed that farmer who had house location in the farm area had the highest pesticide exposure scores (mean =58.59), and higher than the farmers, who located their houses around and outside the farm areas, at the level of .05.

TABLE 4.3.2: Mean and S.D. of Pesticide Exposure Scores in Differences in House Locations

House Location	N	Mean	S.D.
In the farm area	39	58.589	8.611
Around the farm area	19	52.842	5.805
Outside the farm area	15	51.667	9.108
Total	**73**	**55.671**	**8.588**

TABLE 4.3.3: Pesticide Exposure Scores Compared to the Differences in House Locations

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	724.814	2	362.407	5.533	**0.006**
Within Groups	4585.296	70	65.504		
Total	**5310.110**	**72**			

TABLE 4.3.4: Multiple Comparison (LSD) of Pesticide Exposure Scores Compared to the Differences in House Locations

(I) House location	(J) House location	Std. Error	Sig.
In the farm area	Around the farm area	2.264	**0.013**
	Outside the farm area	2.459	**0.006**
Around the farm area	In the farm area	2.264	**0.013**
	Outside the farm area	2.795	0.675
Outside the farm area	In the farm area	2.459	**0.006**
	Around the farm area	2.795	0.675

4.3.3 Pesticide Exposure Scores Compared to Genders

The result of mean testing of pesticide exposure scores showed that there were significant differences of pesticide exposure score between male and female farmers. Male farmer (mean = 59.97) had higher exposure score than female farmer (mean = 51.00) at the level of .05. From the observation, the researcher found that female farmers were more cautious than males, as a result they would wear proper suits and PPD and mix pesticide as recommended.

Table 4.3.5 showed information on mean and standard deviation of the pesticide exposure score according to the farmer genders.

TABLE 4.3.5: Comparison of Pesticide Exposure Scores between Male and Female Farmers

Gender	N	Mean	S.D.	t	Sig. (2-tailed)
Male	38	59.974	7.981	5.206	**0.000**
Female	35	51.000	6.611		

4.3.4 Pesticide Exposure Scores of Farmers Compared to the Differences in Educational Backgrounds

Table 4.3.6 -7 depicted the results of the pesticide exposure scores when compared to their educational background. It revealed that there were no significant differences at the level of .05. The reason was that there were no differences in the educational backgrounds between the sample group since 64 of the samples were graduated from primary school.

TABLE 4.3.6: Mean and S.D. of Pesticide Exposure Scores Compared to the Differences in Educational Backgrounds

Education	N	Mean	S.D.
Uneducated	4	58.750	5.679
First Primary School (Grade 1-4)	36	54.361	9.169
Second Primary School (Grade 5-6)	24	56.292	8.790
Junior High School (Grade 7-9)	5	56.400	7.635
Senior High School (Grade 10-12)	4	59.750	5.252
Total	**73**	**55.671**	**8.588**

TABLE 4.3.7: Pesticide Exposure Scores Compared to the Differences in Educational Backgrounds

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	178.146	4	44.536	0.590	**0.671**
Within Groups	5131.964	68	75.470		
Total	**5310.110**	**72**			

4.3.5 Pesticide Exposure Scores Compared to Smoking Behaviors

From Table 4.3.8, the results of mean testing of pesticide exposure scores showed that there were significant differences of pesticide exposure score between smoking and non-smoking farmer. Non-smoking farmers (mean = 50.97) had lower exposure score than those who smoked (mean = 61.06) at the level of .05. Farmers' smoking behavior may easily lead them to the pesticide exposure. A lot of farmers would smoke while they were working in the farming areas. Their hands would consequently be contaminated with the pesticide unintentionally. Farmers would therefore be exposed to the contaminated cigarette too. Moreover, the tobacco in cigarette would increase the metabolism process. As a result, the inhalation rate of the smoking farmers would be increased and this would lead to the absorption of pesticide more than those who did not smoke.

TABLE 4.3.8: Comparison of Pesticide Exposure Scores Compared to Smoking Behavior

Behavior	N	Mean	S.D.	t	Sig. (2-tailed)
Smoking Farmers	34	61.059	7.458	6.154	**0.000**
Non Smoking Farmers	39	50.974	6.543		

4.3.6 Pesticide Exposure Score of Farmers Compared to the Usage of Spraying Equipment

Table 4.3.9 – 11 depicted the result of the pesticide exposure score comparing with the four differences spraying equipment. It revealed that there were significant differences between pesticide exposure scores and their spraying equipment at the level .05. After testing with the multiple comparison by using LSD, the result revealed the following:

- Farmer, who used motor pump for spraying pesticide, had highest pesticide exposure scores while those who used portable motor, hand pump and both types had lower scores respectively.
- Farmers, who used hand pump for spraying pesticide, had higher pesticide exposure scores more than those who used both hand pump and motor pump.
- Farmers, who used the motor pump, had the higher pesticide exposure score more than those who used hand pump, and those who used both hand pump and motor pump.
- Farmers, who used both hand pump and motor pump, had the lowest pesticide exposure score.
- There were no significant differences in pesticide exposure score between farmers, who used motor pump and portable motor, at the level.05.

TABLE 4.3.9: Mean and S.D. of Pesticide Exposure Scores Compared to the Differences in Spraying Equipment

Spraying equipment	N	Mean	S.D.
Hand pump	35	53.229	7.345
Motor Pump	33	59.091	8.375
Both	2	38.500	3.536
Other (Portable Motor)	3	58.000	3.000
Total	**73**	**55.671**	**8.588**

TABLE 4.3.10: Pesticide Exposure Scores Compared to the Differences in Spraying Equipment

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1200.711	3	400.237	6.720	**0.001**
Within Groups	4109.399	69	59.557		
Total	5310.110	72			

TABLE 4.3.11: Multiple Comparison (LSD) of Pesticide Exposure Scores Compared to the Differences in Spraying Equipment

Spraying Equip.	Spraying Equip.	Std. Error	Sig.
Hand pump	Motor Pump	1.873	**0.003**
	Both	5.611	**0.011**
	Other (Portable Motor)	4.643	0.308
Motor Pump	Hand pump	1.873	**0.003**
	Both	5.620	**0.001**
	Other (Portable Motor)	4.654	0.815
Both	Hand pump	5.611	**0.011**
	Motor Pump	5.620	**0.001**
	Other (Portable Motor)	7.045	**0.007**
Other (Portable Motor)	Hand pump	4.643	0.308
	Motor Pump	4.654	0.815
	Both	7.045	**0.007**

4.3.7 Relationship between Spraying Equipment and Pesticide Exposure Scores

To determine the relationship between spraying equipment and pesticide exposure scores which farmer exposed by using the Eta-Correlation, the result showed that spraying equipment and pesticide exposure scores had positive correlation in the medium level or r = 0.463 at the level .05.

TABLE 4.3.12: Relationship between Spraying Equipment and Pesticide Exposure Scores

Correlation	Variable	Value
Eta	Pesticide Exposure Score Dependent	**.463**

4.3.8 Pesticide Concentration in Working Air Condition Compared to Traditional and IPM Farmers

The comparison results of pesticide concentration between Traditional and IPM farmer were shown in Table 4.3.13. It revealed that Traditional farmers (mean = 0.1865mg/m^3) were significantly exposed to higher concentration than IPM farmers (mean = 0.0370 mg/m^3), at the level .05.

TABLE 4.3.13: Comparison of Pesticide Concentration between Traditional and IPM Farmers

Farmer Group	N	Mean	S.D.	t	Sig. (2-tailed)
Traditional Farmer	18	0.1865	0.1871	3.322	**0.004**
IPM Farmer	15	0.0370	0.0349		

4.3.9 Pesticide Exposure Concentration Compared to the Differences in House Locations

Table 4.3.14 - 15 showed the testing results of the pesticide exposure concentration when compared to their different house locations with ANOVA. It

revealed that there were no significant differences between pesticide exposure concentration with their house locations at the level .05.

TABLE 4.3.14: Mean and S.D. of Pesticide Exposure Concentration in Differences in House Locations

House Location	N	Mean	S.D.
In the farm area	19	0.1350	0.1643
Around the farm area	9	0.1228	0.1840
Outside the farm area	5	0.0485	0.0459
Total	**33**	**0.1186**	**0.1576**

TABLE 4.3.15: Pesticide Exposure Concentration Compared to the Differences in House Locations

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.0299	2	0.0149	0.5859	**0.5628**
Within Groups	0.7652	30	0.0255		
Total	0.7951	32			

4.3.10 Pesticide Concentration in the Working Air Condition Compared to Genders

This was to compare the pesticide concentration in working air condition between male and female farmer. It revealed that there were no significant differences at the level of .05 as shown in Table 4.3.16

TABLE 4.3.16: Comparison of Pesticide Concentration between Male and Female Farmers

Genders	N	Mean	S.D.	t	Sig. (2-tailed)
Male	27	0.1363	0.1689	1.386	**0.176**
Female	6	0.0391	0.0357		

4.3.11 Pesticide Exposure Concentration of Farmers Compared to the Differences in Educational Backgrounds

Table 4.3.17 -18 depicted the results of the pesticide exposure concentration when compared to their educational background, and it revealed that there were no significant differences at the level of .05.

TABLE 4.3.17: Mean and S.D. of Pesticide Exposure Concentration Compared to the Differences in Educational Backgrounds

Education	N	Mean	S.D.
Uneducated & First Primary School	14	0.1083	0.1789
Second Primary School	12	0.1565	0.1749
Junior High School	4	0.0778	0.0335
Senior High School	3	0.0693	0.0570
Total	**33**	**0.1186**	**0.1576**

TABLE 4.3.18: Pesticide Exposure Scores Compared to the Differences in Educational Backgrounds

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.0327	3	0.0109	0.4147	**0.7437**
Within Groups	0.7624	29	0.0263		
Total	**0.7951**	**32**			

4.3.12 Pesticide Exposure Scores Compared to Smoking Behaviors

From Table 4.3.19, the results of mean testing of pesticide exposure concentration showed that there were no significant differences of pesticide exposure concentration between smoking and non-smoking farmer at the level of .05.

TABLE 4.3.19: Pesticide Exposure Scores Compared to Smoking Behavior

Behavior	N	Mean	S.D.	t	Sig. (2-tailed)
Smoking Farmers	26	0.1166	0.1535	0.1403	**0.8893**
Non Smoking Farmers	7	0.1261	0.1850		

4.3.13 Comparison of the Usage of Pesticide Concentration in Solution between traditional and IPM Farmers

This was to compared the pesticide concentration in solution between Traditional and IPM farmers, Table 4.3.20 showed that Traditional farmers (mean = 0.00073 mg/m^3) had been significantly exposed to higher concentration than IPM farmers (mean = 0.00076 mg/m^3) at the level of .05.

TABLE 4.3.20: Comparison of Usage of the Pesticide Concentration in Solution between Traditional and IPM Farmers

Pesticide Concentration in Solution (mg/m^3)	N	Mean	S.D.	t	Sig. (2-tailed)
Traditional	18	0.00073	0.00027	-0.3012	**0.7654**
IPM	15	0.00076	0.00035		

4.3.14 Relationship of Pesticide Concentration in Solution and in Working air Condition

The researcher considered the relationship of pesticide concentration in solution (pesticide dose) and in working air condition. By using Pearson-Correlation,

the result showed in Table 4.3.21 that there were no significant relationship between pesticide concentration in solution and working air at the level .05.

TABLE 4.3.21: Correlation between Pesticide Concentration in Solution and in Working Air Condition

Pesticide Concentration (mg/m^3)	Mean	S.D.	N	Pearson Correlation	Sig. (2-tailed)
In Solution	0.00075	0.0003	33	-.113	**0.531**
In Working Air Condition	0.11860	0.1576	33		

4.3.15 Pesticide Exposure Concentration Compared to the Differences in Pesticide Types

Table 4.3.22 -23 showed the results of the pesticide concentration when compared to the pesticide types. It revealed that there were no significant differences between farmers who used chlorpyrifos, methyl parathion and both chlorpyrifos and methyl parathion at the level of .05.

TABLE 4.3.22: Mean and S.D. of Pesticide Exposure Concentration Compared to the Differences in Pesticide Types

Pesticide Concentration	N	Mean	S.D.
Chlorpyrifos	23	0.201	0.194
Methyl parathion	7	0.039	0.040
Both chlorpyrifos & methyl parathion	3	0.054	0.023
Total	**33**	**0.119**	**0.158**

TABLE 4.3.23: Pesticide Exposure Concentration Compared to the Differences in Pesticide Types

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.107	2	0.054	2.342	**0.114**
Within Groups	0.688	30	0.023		
Total	**0.795**	**32**			

4.3.16 Pesticide Exposure Concentration Compared to the Differences in Spraying Equipment

According to Table 4.3.24 - 26, the result of the pesticide concentration was compared to the 3 different spraying equipment. It revealed that there were significant differences between pesticide concentration and their spraying equipment at the level .05. After testing with the multiple comparison by using LSD, the result revealed that the farmers who used motor pump had significant different pesticide concentration. The details were the following:

- Farmers, who used motor pump had been exposed to higher concentration than those used hand pump
- There were no significant differences between farmers, who used motor pumps and those who used portable motors.
- There were no significant differences between farmers, who used hand pumps and those who used portable pumps.

TABLE 4.3.24: Mean and S.D. of Pesticide Exposure Concentration Comparing with the Difference in Spraying Equipment

Spraying equipment	N	Mean	S.D.
Motor Pump	16	0.201	0.194
Hand Pump	14	0.038	0.040
Portable Motor	3	0.054	0.023
Total	**33**	**0.119**	**0.158**

TABLE 4.3.25: Pesticide Exposure Concentration Compared to the Differences in Spraying Equipment

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.211	2	0.106	5.429	**0.010**
Within Groups	0.584	30	0.020		
Total	**0.795**	**32**			

TABLE 4.3.26: Multiple Comparison (LSD) of Pesticide Exposure Concentration Compared to the Differences in Spraying Equipment

Spraying Equip.	Spraying Equip.	Std. Error	Sig.
Motor Pump	Hand Pump	0.051	**0.003**
	Portable Motor	0.088	0.105
Hand Pump	Motor Pump	0.051	**0.003**
	Portable Motor	0.089	0.860
Portable Motor	Motor Pump	0.088	0.105
	Hand Pump	0.089	0.860

4.3.17 Relationship between Spraying Equipment and Pesticide Exposure Concentration

To determine the relationship between spraying equipment and pesticide exposure concentration which farmer exposed by using the Eta-Correlation, the result showed that spraying equipment and pesticide exposure concentration had positive correlation in the medium level or r = 0.516 at the level of .05.

TABLE 4.3.27: Relationship between Spraying Equipment and Pesticide Concentration (mg/m^3)

Correlation	Variable	Value
Eta	Spraying Type Dependent	1.000
	Pesticide Exposure Concentration (mg/m^3) Dependent	**.516**

The summary of statistical analysis results in this study were shown in Table 4.3.28 - 30

TABLE 4.3.28: Results from the Statistical Analysis in Pesticide Exposure Scores

Test Statistic	Results	Description
t-Test		
1. Farmer Group	Significant differences	Traditional > IPM Farmers 58.30 : 53.50
2. Farmer Gender	Significant differences	Male > Female Farmers 59.97 : 51.00
3. Smoking Behaviors	Significant differences	Smoking > Non-Smoking 61.06 : 50.97
ANOVA		
1. House Locations	Significant differences	Farmer who had house location in the farm area had significant differences in pesticide exposure scores.
2. Educational Backgrounds	No Significant differences	Farmer who had different educational backgrounds had no significant differences in pesticide exposure scores
3. Spraying Equipment	Significant differences	Farmer who using different spraying equipment had significant differences in exposure sores
Eta-Correlation between Spraying Equipment and Exposure Scores	r =0.463	There were relationship between spraying equipment and pesticide exposure scores at the medium level

TABLE 4.3.29: Results from the Statistical Analysis in Pesticide Concentration

Test Statistic	Results	Description
t-Test **1. Farmer Group**	Significant Differences	Traditional > IPM Farmers 0.1865 : 0.0370 mg/m^3
2. Farmer Gender	No Significant Differences	Male and Female Farmers had no significant differences in pesticide exposure concentration.
3. Smoking Behaviors	No Significant Differences	Smoking and Non-Smoking farmers had no significant difference in pesticide exposure concentration.
ANOVA **1. House Locations**	No Significant Differences	Farmers, who had the different house locations had no significant differences in exposure to pesticide concentration in working air condition
2. Educational Backgrounds	No Significant Differences	Farmer with difference in educational backgrounds had no significant differences in exposure to pesticide concentration in air condition
3. Spraying Equipment	Significant Differences	Farmers, who used different spraying equipment had significant differences in exposure to pesticide concentration
Eta-Correlation between Spraying Equipment and Exposure Conc	r =0.516	There were relationship between spraying equipment and pesticide concentration in the working air condition at the medium level

TABLE 4.3.30: Results from Statistical Analysis of Interesting Variables

Test Statistic	Result	Description
t-test Usage of Pesticide Concentration in Solution Compared to Tradition and IPM Farmers	No Significant Differences	Traditional and IPM farmers applied the pesticide in the same concentration.
ANOVA Pesticide Exposure Concentration Compared to the Differences Pesticide Types	No Significant Differences	Farmers exposed pesticide in the same concentration.
Pearson-Correlation Pesticide Concentration in Solution & Pesticide Concentration in Working Air Condition	No Correlation	There were no relationship between the pesticide concentration in solution and pesticide concentration in working air condition

4.4 Exposure Assessment

The researcher categorized the pesticide exposure in Bang Rieng farmers into two items. Firstly, "Exposure Concentration" means a Chemical Concentration in a function of time, and secondly, "Intake Concentration" meant the average exposure over a constant time of interest (Lawrence B., 1996).

4.4.1 Exposure Concentration

From the equation:

$$\mathbf{E = C\ \Delta t}$$

where

C = the average chemical concentration

Δt = the time duration of exposure

To estimate the total inhalation exposure during spraying pesticide for farmers, the researcher assumed the following factors to calculate for Thai farmers only:

Working Duration	:	Starting from age 20 to 65 years old.
Working Day	:	Average 300 days/year
Working Hour (Spraying)	:	Average 0.5 hrs/day
Mean of Pesticide Concentration:		mean of all pesticide in this study = 0.1186 mg/m^3
Max. Pesticide Concentration:		0.6055 mg/m^3
Min. Pesticide Concentration:		0.0040 mg/m^3
Inhalation Rate	:	For heavy activity = 6.0 m^3/hr

Then, the followings showed the calculation method:

$\text{Working Time}_{\text{in farm}}$ = (65 - 20 yrs) x 300 workdays/yr x 0.5 hrs/day

= 6,750 hrs.

Next, Exposure Oraganophosphate Pesticide in working air condition

$$E_{OPair} = (C_{in\ farm} \times \text{Working Time}_{in\ farm})$$

To calculate Mean of pesticide concentration

$E_{OPair\text{-}Mean} = (0.1186\ mg/m^3 \times 6{,}750\ hrs.) = 800.55\ mg.hr/m^3$

To calculate Maximum pesticide concentration

$E_{OPair\text{-}Max} = (0.6055\ mg/m^3 \times 6{,}750\ hrs.) = 4{,}087.13\ mg.hr/m^3$

To calculate Minimum pesticide concentration

$E_{OPair\text{-}Min} = (0.0040\ mg/m^3 \times 6{,}750\ hrs.) = 27.0\ mg.hr/m^3$

Finally, to calculate Mean of Concentration and all lifetime farmers, they will be exposed to organophosphate pesticide from spraying at the inhalation rate of 6.0 m^3/hr as follows:-

$E_{OPair\text{-}Mean} = (2{,}401.7\ mg.hr/m^3) \times (6\ m^3/hr \times 0.5\ hr)$

$= 2{,}401.65\ mg$

To calculate Maximum Concentration and all lifetime farmers:

$E_{OPair\text{-}Max} = (65{,}394.0\ mg/m^3) \times (6\ m^3/hr \times 0.5\ hr)$

$= 12{,}267.36\ mg$

To calculate Minimum Concentration and all lifetime farmers:

$E_{OPair\text{-}Min} = (432.0\ mg/m^3 \times (6\ m^3/hr \times 0.5\ hr)$

$= 81.00\ mg$

Equation Interpretations

1. If the pesticide concentration from spraying in the working air equaled the Mean of pesticide concentration (0.1186 mg/m^3), the farmers would be expose to 2401.65 mg of organophosphate pesticide into their inhalation system for their lifetime period.
2. If the pesticide concentration from spraying in the working air equaled the Maximum concentration (0.6055 mg/m^3), the farmers would be expose to

12,261.38 mg. of organophosphate pesticide into their inhalation system for their lifetime period.

3. If the pesticide concentration from spraying in the working air equaled the Minimum concentration (0.0040 mg/m^3), the farmers would be expose to 81.00 mg of organophosphate pesticide into their inhalation system for their lifetime period.

4.4.2 Intake Concentration

A generalized equation for the intake was

$$\mathbf{I = (C \times CR \times EF \times ED)/(BW \times AT)}$$

where

I	=	Intake Concentration (mg/kg·day)
C	=	Chemical Concentrations at the Exposure point (mg/m^3)
CR	=	Contact Rate (m^3/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (average over exposure period: kg.)
AT	=	Average Time (days)

The researcher determined some factors to calculate BW, FI, EFD and AT for proper results. Those factors will be assumed for Thai farmers as follows:

CR	=	Breathing Rate = 3.0 m^3/hr, calculated from breathing rate in heavy activity (spraying pesticide: 6.0 m^3/hr) and multiply by 0.5 hr for spraying pesticide period.
BW	=	65 kilogram (for both male and female)
EF	=	52 days/year (average time for applying pesticide = 4 times/month)
ED	=	Farming period = 45 years
AT	=	calculated from farming duration (45 years) multiply by amount of spraying days/year (52 days)
ADI	=	- for all concentration in this study = 0.015 mg/kg·day

- for chlorpyrifos = 0.010 mg/kg day
- for methyl parathion = 0.020 mg/kg day
- for Both chlorpyrifos and methyl parathion = 0.015 mg/kg day

The final results from the intake concentration calculation and its results when compared to ADI recommended are shown in Table 4.4.1

TABLE 4.4.1: Intake Concentration from being Exposed to Organophosphate Pesticide to Inhalation System

Pesticide Type		Concentration (mg/m^3)	Intake (mg/kg day)	Compared to ADI (Percentage)
Total (all concentration)	Mean	0.1186	0.005	**36.49**
	Max	0.6055	0.0279	**186.31**
	Min	0.0040	0.0002	**1.23**
Chlorpyrifos	Mean	0.1558	0.0072	**71.91**
	Max	0.6055	0.0279	**279.46**
	Min	0.0204	0.0009	**9.42**
Methyl parathion	Mean	0.0236	0.0011	**5.45**
	Max	0.0695	0.0032	**16.04**
	Min	0.0040	0.0002	**0.92**
Both (chlorpyrifos & methyl parathion)	Mean	0.0545	0.0025	**16.77**
	Max	0.1284	0.0059	**39.51**
	Min	0.0094	0.0004	**2.89**

4.4.3 Comparison of Exposure Concentration between Traditional and IPM Farmers

In this study, the researcher showed the results from the calculation of the pesticide exposure concentration which each groups will be expose to.

To estimate the total inhalation exposure during spraying pesticide for Traditional and IPM farmers, the researcher determined the following factors to calculate especially for both farmers:

Working Duration:	Starting from age 20 to 65 years old.
Working Day:	Average 300 days/year
Working Hour:	- Average 0.4 hrs/day for Traditional Farmers
	- Average 0.58 hrs/day for IPM Farmers
Mean of Pesticide Conc.:	For Traditional farmers = 0.1186 mg/m^3
	For IPM farmers = 0.0370 mg/m^3
Max. Pesticide Conc.:	For Traditional farmers = 0.6055 mg/m^3
	For IPM farmers = 0.1324 mg/m^3
Min. Pesticide Conc.:	For Traditional farmers = 0.0168 mg/m^3
	For IPM farmers = 0.0040 mg/m^3
Inhalation Rate:	For heavy activity = 6.0 m^3/hr
Spraying Time:	For Traditional farmers = 24 min or 0.4 hr/day
	For IPM farmers = 34.8 min or 0.58 hr/day

Then, the followings showed the calculation method:

Traditional farmers had Working $Time_{in\ farm}$

= (65 - 20 yrs) x 300 workdays/yr x 0.4 hrs/day

= 5,400 hrs.

IPM farmers had Working $Time_{in\ farm}$

= (65 - 20 yrs) x 300 workdays/yr x 0.58 hrs/day

= 7,830 hrs.

Next, Exposure Oraganophosphate Pesticide in working air condition was:-

$$E_{OPair} = (C_{in\ farm} \times \text{Working } Time_{in\ farm})$$

For Traditional Farmer:

To calculate Mean of pesticide concentration

$E_{OPair\text{-}Mean}$ = (0.1186 mg/m^3 x 5,400 hrs.) = 1,007.38 $mg.hr/m^3$

To calculate Maximum pesticide concentration

$E_{OPair\text{-}Max}$ = (0.6055 mg/m^3 x 5,400 hrs.) = 3,269.43 $mg.hr/m^3$

To calculate Minimum pesticide concentration

$E_{OPair\text{-}Min}$ = (0.0168 mg/m^3 x 5,400 hrs.) = 90.46 mg.hr/m^3

For IPM Farmer:

To calculate Mean of pesticide concentration

$E_{OPair\text{-}Mean}$ = (0.0370 mg/m^3 x 7,830 hrs.) = 289.85 mg.hr/m^3

To calculate Maximum pesticide concentration

$E_{OPair\text{-}Max}$ = (0.1324 mg/m^3 x 7,830 hrs.) = 1,036.32 mg.hr/m^3

To calculate Minimum pesticide concentration

$E_{OPair\text{-}Min}$ = (0.0040 mg/m^3 x 7,830 hrs.) = 31.00 mg.hr/m^3

Finally, to calculate Mean concentration and all lifetime farmers, they will be exposed to organophosphate pesticide from spraying at the inhalation rate of 6.0 m^3/hr as follows

For Traditional Farmer:

To calculate Mean of Concentration and all lifetime farmers:

$E_{OPair\text{-}Mean}$ = (1,007.38 mg.hr/m^3) x (6 m^3/hr x 0.4 hr)
= 2,417.70 mg

To calculate Maximum Concentration and all lifetime farmers:

$E_{OPair\text{-}Max}$ = (3,269.43 mg/m^3) x (6 m^3/hr x 0.4 hr)
= 7,846.64 mg

To calculate Minimum Concentration and all lifetime farmers:

$E_{OPair\text{-}Min}$ = (90.46 mg/m^3) x (6 m^3/hr x 0.4 hr)
= 217.10 mg

Equation Interpretations

1 If the pesticide concentration from spraying in the working air equaled the Mean of pesticide concentration (0.1186 mg/m^3), the farmers would be

expose to 2,417.70 mg of organophosphate pesticide into their inhalation system for their lifetime period.

2 If the pesticide concentration from spraying in the working air equaled the Maximum concentration (0.6055 mg/m^3), the farmers would be expose to 7,846.64 mg. of organophosphate pesticide into their inhalation system for their lifetime period.

3 If the pesticide concentration from spraying in the working air equaled the Minimum concentration (0.0040 mg/m^3), the farmers would be expose to 217.10 mg of organophosphate pesticide into their inhalation system for their lifetime period.

For IPM Farmer:

To calculate Mean of Concentration and all lifetime farmers:

$$E_{OPair\text{-}Mean} = (289.85 \text{ mg.hr/m}^3) \times (6 \text{ m}^3\text{/hr} \times 0.58 \text{ hr})$$
$$= 1{,}008.66 \text{ mg}$$

To calculate Maximum Concentration and all lifetime farmers:

$$E_{OPair\text{-}Max} = (1{,}036.32 \text{ mg/m}^3) \times (6 \text{ m}^3\text{/hr} \times 0.58 \text{ hr})$$
$$= 3{,}6006.40 \text{ mg}$$

To calculate Minimum Concentration and all lifetime farmers:

$$E_{OPair\text{-}Min} = (31.00 \text{ mg/m}^{3)} \times (6 \text{ m}^3\text{/hr} \times 0.58 \text{ hr})$$
$$= 107.87 \text{ mg}$$

Equation Interpretations

1 If the pesticide concentration from spraying in the working air equaled the Mean of pesticide concentration (0.0370 mg/m^3), the farmers would be expose to 1,008.66 mg of organophosphate pesticide into their inhalation system for their lifetime period.

2 If the pesticide concentration from spraying in the working air equaled the Maximum concentration (0.1324 mg/m^3), the farmers would be expose to 3,606.40 mg. of organophosphate pesticide into their inhalation system for their lifetime period.

3 If the pesticide concentration from spraying in the working air equaled the Minimum concentration (0.0040 mg/m^3), the farmers would be expose to 107.87 mg of organophosphate pesticide into their inhalation system for their lifetime period.

4.4.4 Comparison of Intake Concentration between Traditional and IPM Farmers

The researcher determined some factors to calculate intake concentration for Thai farmers. Those factors will be assumed as follows:

CR = For Traditional farmer breathing rate = 2.4 m^3/hr, calculated from breathing rate in heavy activity (spraying pesticide: 6.0 m^3/hr) and multiply by 0.4 hr for spraying pesticide period.
For IPM farmer breathing rate = 3.48 m^3/hr (from 6.0 m^3/hr x 0.58 hrs)

BW = 65 kilogram (for both male and female)

EF = For Traditional farmers = 52 days/year (average time for applying pesticide = 4.33 times/month)
For IPM farmers = 35 days/year (average time for applying pesticide = 2.87 times/month)

ED = Farming period = 45 years

AT = calculated from farming duration (45 years) multiply by amount of spraying days/year (52 days)

ADI = - for chlorpyrifos = 0.010 mg/kg·day
- for methyl parathion = 0.020 mg/kg·day

HQ = Hazard Quatient = Intake / ADI

The final results from the intake concentration calculation and its results when compared with ADI recommended and HQ were shown in Table 4.4.2

TABLE 4.4.2: Intake Concentration from being Exposed to Organophosphate Pesticide to Inhalation System of each Farmer Group

Farmers Group	C mg/m^3	CR m^3/day	EF days	AT one year days	Intake mg/kg.day	Chlorpysifos		Methyl parathion	
						%ADI	HQ (Intake /ADI)	%ADI	HQ (Intake /ADI)
Traditional									
Mean	0.1866	2.4	52	2340	**0.0069**	**68.88**	**0.69**	**34.44**	**0.34**
Max	0.6055	2.4	52	2340	**0.0224**	**223.55**	**2.24**	**111.78**	**1.12**
Min	0.0168	2.4	52	2340	**0.0006**	**6.19**	**0.06**	**3.09**	**0.03**
IPM									
Mean	0.0370	3.48	35	2340	**0.0013**	**13.34**	**0.13**	**6.67**	**0.07**
Max	0.1324	3.48	35	2340	**0.0048**	**47.69**	**0.48**	**23.85**	**0.24**
Min	0.0040	3.48	35	2340	**0.0001**	**1.43**	**0.01**	**0.71**	**0.01**