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# The Chemical Management Using Safety Theory for Farmers in Ubon Ratchathani Province

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**ABSTRACT:** This is quasi-experimental research on the chemical management using the safety theory for farmers in Ubon Ratchathani Province. The population was the select 782 households voluntarily to participate in the research project. One person per household was selected. As a result, a total of 213 samples were obtained. The research was conducted by implementing a safety program based on the 3E principle for 3 consecutive months to the samples. The data were analyzed using descriptive statistics and inferential statistics (paired sample t-test).

The results revealed that most of the farmers (94.8%) used liquid chemicals, especially herbicides, aphicides and insecticides with a high level of exposure to chemicals. After the safety program was implemented, the satisfaction also significantly increased compared to that of before the safety program was implemented (P-Value < 0.001In terms of Engineering, according to the design of a chemical fume hood, the air velocity was 0.31 m/s compared to the ACGIH standard that the air velocity must be between 0.25-0.5 m/s. Therefore, the chemical fume hood met the ACGIH standard. In terms of Enforcement, it gained a high level of satisfaction.

In conclusion, the chemical management based on the 3E principle can appropriately manage safety in chemical use in the community by enhancing farmers' knowledge and attitudes, leading to safety behaviors in chemical use in the community in a better direction. Therefore, it can be applied to safety management in other communities.

**KEYWORDS:** Safety management, safety theory, chemical use.

## INTRODUCTION

Thailand is the world's 13th largest producer and exporter of agricultural products, so Thai agricultural products rely mainly on foreign markets (Office of Agricultural Economics). At the same time, Thailand is ranked 7th for the country's annual pesticide use when measuring the chemical use per agricultural areas of the world's top 30 countries with agricultural areas. As a result, the amount of the toxic substances used in Thailand is also among the top in the world. In Thailand in 2019, the imports of 88,846 tons of pesticides and 19,334 tons of plant pathological protection chemicals were reported (Thailand Pesticide Alert Network).

According to the situation of pesticide poisoning report (2001- 2020), 46,874 cases with the average of 2,344 cases per year and 49 deaths were reported. The highest number of cases was reported in 2020. There were 5,721 cases or 8.62 cases per 100,000 people. It was mostly found among those having agricultural occupations, which was 1,749 cases (30.57%) (Department of Disease Control).

The agricultural areas in Ubon Ratchathani Province are 5,549,799 rai, accounting for 53.14% of the total area. In addition, 311,630 households are engaged in agricultural occupations. Muang Sam Sip District has an agricultural area of 17,865 households, which is 1 in 10 agricultural areas in the province and 1 in 3 large districts that do vegetable farming for selling in the urban markets in Ubon Ratchathani Province and in the country that still use pesticides in agriculture (Agricultural Statistics of Thailand).

As for the situation of agricultural chemical use in the lower Mekong Basin and Ubon Ratchathani Province, most farmers still use a lot of agricultural chemicals, including insecticides, fungicides and herbicides. As a result, there are residues in the soil and water sources. These chemicals also affect the health of farmers in terms of both acute and chronic toxicity. This is mainly due to the use of chemicals in large quantities than necessary and the incorrect use of chemicals. In some countries, farmers still use agricultural chemicals that are prohibited for sale. However, the agricultural system in the Mekong Basin tends to improve and develop better practices in the future (Petchuay).

Pesticide use not only affects the users' health but also the consumers of agricultural products, both people and pets. For this reason, there is an unsafe use of chemicals in the community due to occupations, the community safety management system and occupational diseases

(Chemical Surveillance Report, Division of Occupational and Environmental Diseases). These will affect health and cause insecurity, affecting the health of individuals, families, communities and consumers in terms of both acute and chronic diseases, leading to death.
According to the situation of the amount of pesticide use by farmers and the reports of health impacts affecting the quality of life of users and insecurity in community life, the researchers were interested in studying the safety management of chemical use using the safety theory for farmers in Ubon Ratchathani Province in order to manage the safety of chemical use and control the exposure to chemicals that will negatively affect health and harm the lives of farmers.

**OBJECTIVES**

1. To study the risk assessment of safety in chemical use
2. To study the safety management of chemical use using the safety theory for farmers in Ubon Ratchathani Province

**METHODOLOGY**

This is quasi-experimental research on the chemical management using the safety theory for farmers in Ubon Ratchathani Province. The population was the representative of the population of 25 districts. Muang Sam Sip District was selected for the most horticultural agriculture and pesticide use. Purposive random sampling was administered to select 782 households voluntarily to participate in the project. One person per household was selected. As a result, a total of 213 samples were obtained. The ethical approval was obtained before giving the safety program based on the 3E principle for 3 consecutive months to the samples. Data were collected using a questionnaire that was tested for quality. The content validity and the reliability of the questionnaire were 0.76 and 0.82, respectively. The data were analyzed using descriptive statistics (mean, frequency, percentage, standard deviation) and inferential statistics (paired sample t-test).

**POPULATION AND SAMPLE**

The population was the representative of the population of 25 districts. Muang Sam Sip District was selected for the most horticultural agriculture and pesticide use. Purposive random sampling was administered to select 782 households voluntarily to participate in the research project. One person per household cultivating and using pesticides who voluntarily participated in the project was selected. As a result, there were 213 samples in total.

**RESEARCH TOOLS**

The questionnaire created by the researchers were used as the tool in the study based on the 3E safety theory. In terms of Education, the questionnaire was divided into 4 parts as follows. Part 1: A personal information questionnaire: It consisted of 12 items on gender, age, education level, occupation, type of vegetables, income, chemical use, type of chemicals, amount of chemical use, chemical use methods, hours of chemical use and abnormal symptoms while using chemicals. Part 2: Questionnaire on farmers' general knowledge on pesticide use: There were 20 positive meaning questions with two options: Yes or No. Part 3: Questionnaire on the attitudes of farmers towards pesticide use: It consisted of 20 positive meaning questions with three options: Agree, Not Sure, Disagree. Part 4: Questionnaire on farmers' self-protection behaviors in pesticide use: It consisted of 20 positive meaning questions with three options: Always, Sometimes, never. In terms of Engineering, ACGIH standard of 0.25 -0.5 m/s was employed. In the terms of Enforcement, the satisfaction assessment form on the design of a chemical fume hood and a manual for chemical use in the community was used. The content validity and the reliability of the questionnaire were 0.74 and 0.82, respectively. Conceptual framework, Fig. 1

**DATA COLLECTION**

Data were collected by using a survey on five hazards: chemical, physical, biological, ergonomics and psychosocial hazards. The survey results were used to create a questionnaire to assess the Education. The satisfaction assessment form was created by the researchers from studying and researching from textbooks and related research consistent with the objectives and conceptual framework. The research team meeting was held to determine the methods for conducting the research and prepare a request for permission to visit the target area. The samples were selected. The protection of the samples' rights was conducted by holding a meeting to clarify the objectives, the researchers' roles, the participants' rights and the guidelines for protecting the participants' interests. The research was approved for research in human subjects (EC R002/65) by Ubon Ratchathani Rajabhat University before conducting the research and collecting data from the samples that voluntarily participated in the research project. The sample codes were specified, and personal data were classified. The methods for destroying the data when the analysis was complete were also determined.

**DATA ANALYSIS**

1. Descriptive Statistics were used to describe general data (frequency, percentage, mean, and standard deviation).
2. Inferential statistics were used to test the assumptions of the differences before and after the implementation of the safety program based on the safety theory using parried samples t-test.

**RESULTS**

**General information for the farmers**

The study results of the general information of all 213 farmers revealed that there were 124 males (58.2%) and 89 females (41.8%) with the average age of 51.9 years old. Most of them were in the age range of 25-50 years (110 people or 51.6%). The highest level of education was primary school (120 people or 56.3%). Most of them had agricultural occupations (201 people or 94.4%). The average monthly income was 5,931 baht. Their income mostly was less than 5,000 baht per month (33 people or 62.4%). Chili was mostly planted (81 people or 38.0%), followed by vegetables (78 people or 36.0%), chili and vegetables (44 people or 20.7%) and corn and rice (10 people or 4.7). They used herbicides, aphicides, insecticides, fungicides, termiticides, miticides and vermicides (39 people, 137 people, 117 people, 82 people, 64 people, 19 people and 101 people or 18.7%, 64.3%, 54.9%, 35.5%, 30%, 8.9% and 47.4%, respectively). Most of them used liquid chemicals (202 people or 94.8%). The highest frequency of chemical use was two times per month (121 people or 56.8%), followed by one time per month (74 people or 34.7%), 3-4 times a week (10 people or 4.7%) and every day and every other day (8 people or 3.8%). Most of them used a manual pesticide sprayer pump (103 people or 48.4%), a hand sprayer (87 people or 40.8%) and a high-pressure pump (23 people or 10.8%). Most of them spent one hour for chemical use per time (201 people or 94.4%), followed by two hours per time (9 people or 4.3%) and more than three hours per time (3 people or 1.3%). Most of them experienced dizziness while using or being exposed to chemicals (70 people or 32%).

**Results based on the research objectives**

**1. To study the risk assessment of safety in chemical use**

**1.1. Results of a survey on the safety of chemical use in the community**

**Table 1**, percentage of the samples at risk of exposure to agricultural chemicals (n = 213) From Table 1, a survey of the safety of chemical use in the community revealed that there was a risk of exposure to abamectin, triazophos (Red Box) and organophosphate (1B), FIPRONIL, imidacloprid and carbosulfan (179 people, 178 people, 187 people, 184 people, and 181 people or 84.8%, 83.6%, 87.8%, 84.4% and 85.0%, respectively).

**1.2 Results of safety risk assessment of chemical use in the community**

**Table 2** Results of the risk assessment levels on the use of agricultural chemicals in the community

From Table 2, the study results of the safety of chemical use in the community revealed that there was a high level of risk assessment for exposure to agricultural chemicals in the community. The assessment score was 8 points out of a full score of 16 points.

**2. To study the safety management of chemical use using the 3E safety theory for farmers in Ubon Ratchathani Province**

**2.1 The results based on the safety principle in Education and assessment of knowledge, attitudes and self-protective behaviors in pesticide use among farmers**

**2.1.1 Results of the knowledge on pesticide use among farmers**

From Table 3, the knowledge on pesticide Use before implementing the safety program of most of the farmers was at a high level (83 people or 39%), followed by a low level (74 people or 34.7%), and a moderate level (56 people or 26.3%). After the safety program was implemented, the knowledge of most of the farmers was at a high level (200 people or 93.9%), followed by a moderate level (12 people or 5.6%) and a low level (1 person or 0.5%).

**2.1.2 Results of the attitudes towards pesticide use among farmers**

From Table 4, the attitudes towards pesticide use of most of the horticultural farmers before implementing the safety program was at a moderate level (147 people or 69.0%), followed by a high level (64 people or 30.1%) and a low level (2 people or 0.90%). After the safety program was implemented, the attitudes of most of the farmers was at a high level (195 people or 92.0%), followed by a moderate level (16 people or 7.7%) and a low level (1 person or 0.5%).

**2.1.3 Results of the self-protective behaviors in** pesticide use **among farmers**

From Table 5, the self-protective behaviors in pesticide use before implementing the safety program of most of the farmers was at a moderate level (119 people or 55.9%), followed by a high level (84 people or 39.4%) and a low level (10 people

or 4.70%). After implementing the safety program, the self-protective behaviors of most of the farmers was at a high level (205 people or 92.0%), followed by a moderate level (7 people or 3.3%) and a low level (1 person or 0.5%).

From Table 6, the mean scores before and after the safety program was implemented in all three aspects, namely knowledge, attitudes and self-protective behaviors in chemical use, were significant different at the *p*-value < 0.001.

**2.2. Results based on the safety principles in Engineering and Enforcement, the design of a chemical fume hood and a manual for chemical use in the community**

Figure 2 shows the results of the design of a chemical fume hood with community participation. The air velocity was set at the respiratory level of the worker 75 cm away from the pollution source. The cross-sectional area in front of Hood (A) = 0.60 meters X 0.60 meters, equal to 0.36 square meters. The average air velocity was 0.31 meters per second compared to ACGIH standard of volatile substances from a chemical tank (no speed) in still air that the recommended air velocity is 0.25 -0.5 m/s.

**2.2.1 Results of satisfaction analysis on the design of a chemical fume hood and a manual for chemical use in the community**

From Table 7, the satisfaction on the design of safety of a chemical fume hood and a manual for chemical use in the community of the majority of the community was at a high level, (159 people or 74.7%), followed by a moderate level (54 people or 25.4%).

**DISCUSSION**

This is quasi-experimental research on the chemical management using the safety theory for farmers in Ubon Ratchathani Province. The research was conducted by implementing a safety program based on the 3E principle, Engineering, Education, Enforcement. The results revealed that most of the farmers (94.8%) used liquid chemicals, especially herbicides, aphicides and insecticides, with a high level of exposure to chemicals. This is consistent with the situation of pesticide poisoning report (2001- 2020) of the Department of Disease Control, Information System Development and Emergency Response Team, Division of Occupational and Environmental Diseases that 46,874 cases with an average of 2,344 cases per year and 49 deaths were reported. The highest number of cases was reported in 2020. There were 5,721 cases or 8.62 cases per 100,000 people. It was mostly found among those having agricultural occupations, which was 1,749 cases (30.57%). After the safety program was implemented, in terms of Education, there was a statistically significant increase of the mean scores of knowledge attitudes and behaviors on the chemical use in the community, compared to those of before the implementation of the safety program (*P*-Value < 0.001). These findings are consistent with the following research studies. A study by Philippe Chan, et al., studied the safety concepts and awareness without causing real harm to the users themselves or others. The study examined person-centered variables using training together with safety gaming activities. It was found that the target group's awareness after receiving the program increased. A study by Srimanon investigated the effects of behavior modification program in self-protection from pesticides of farmers with at-risk and unsafe blood levels by applying health belief model theory. The findings revealed that after receiving the program, the sample's scores on knowledge, perception and behavior in using pesticides significantly increased. A study by Charoensuk on the effectiveness of safety training program in pesticides utilization of farmers in Donchedi District, Suphanburi Province found that after being trained with the pesticide safety program, the farmers' knowledge significantly increased. Moreover, a study by Duangpratoom et al, investigating the effects of safety behaviors promoting program from pesticide use of farmers in Si-Prachan District, Suphan Buri Province revealed that there were statistically significant changes in the farmers' knowledge, attitudes and behaviors towards pesticide use after receiving the program. Yokphochanacha explored the effects of the household fire prevention safety program in Ban Bok households, Muang Sam Sip District, Ubon Ratchathani Province. The program was continuously conducted with 8 activities for 14 weeks. The findings revealed that after the program intervention, there were statistically significant improvements in the samples' scores. In terms of Engineering, according to the design of a chemical fume hood, the air velocity was 0.31 m/s, which was consistent with the ACGIH standard of volatile substances from a chemical tank (no speed) in still air that recommended air velocity is 0.25 -0.5 m/s. In terms of Enforcement, it gained a high level of satisfaction. This aligns with a study by Mailidan Motalifu a, entitled "Chemical process safety education in China: An overview and the way forward". Chemical safety management programs were organized for interdisciplinary graduates to create safety courses, leading to the design of correct safety prevention practices.

In conclusion, the chemical management using the safety theory for farmers in Ubon Ratchathani Province can properly manage the safety of chemical use in the community. It can also to increase the scores on knowledge, attitudes and safety behaviors in chemical use in the community. Therefore, it can be applied to the safety management in other communities.

**RECOMMENDATIONS**

1. Regular annual health examinations should be conducted in the community every year.
2. The government should support and formulate the policies to promote organic agriculture in agricultural areas.

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Tables 1, percentage of the samples at risk of exposure to agricultural chemicals

**Table 1. Number, percentage of the samples at risk of exposure to agricultural chemicals (n = 213)**

| No. | Details in compliance with laws and SDS | Risk of exposure | |
|---|---|---|---|
| | | Yes Number (Percentage) | No Number (Percentage) |
| **1.** | **Using aphicides such as abamectin** | **179(84.0)** | **34(16.0)** |
| | 1.1 Chemical protective equipment is used because it is a psychoactive substance. | 54(25.4) | 159(74.6) |
| | 1.2 Pregnant women are exposed to chemicals because they are harmful to the fetus. | 32(15.0) | 181(85.0) |

| No. | Details in compliance with laws and SDS | Risk of exposure | |
|---|---|---|---|
| | | Yes Number (Percentage) | No Number (Percentage) |
| | 1.3 Hands are washed immediately after a chemical exposure as it is deadly if ingested. | 32(15.0) | 181(85.0) |
| | 1.4 A chemical respirator is worn because it is deadly if inhaled. | 22(10.3) | 191(89.7) |
| | 1.5 Body protective clothing is used because the chemicals are dangerous to the organs after prolonged or repeated exposure. | 22(10.3) | 191(89.7) |
| | 1.6 Chemicals are prevented from leaking or flowing into water sources because they are very toxic to aquatic organisms and have long-term effects. | 19(8.9) | 194(91.1) |
| | 1.7 The labels are always read before using chemicals because they are classified as hazardous substances according to the Notification of the Ministry of Industry on the List of Hazardous Substances, 2013. | 16(7.5) | 197(92.5) |
| 2. | **Using maggoticides such as triazophos (Red Box), organophosphate (1B)** | **178(83.6)** | **35(16.4)** |
| | 2.1 A chemical respirator is worn because it is deadly if inhaled. | 22(10.3) | 191(89.7) |
| | 2.2 Hands are washed immediately after a chemical exposure because it is deadly if ingested. | 37(17.4) | 176(82.6) |
| | 2.3 Body protective clothing is used because it is dangerous when chemicals come into contact with skin. | 23(10.8) | 190(89.2) |
| | 2.4 Chemicals are prevented from leaking or flowing into water sources because they are very toxic to aquatic organisms and have long-term effects. | 30(14.1) | 183(85.9) |
| | 2.5 Chemicals are properly stored and transported according to the Manual for Chemical and Hazardous Substances Storage, Notification of the Department of Industrial Works, 2007 due to flammable solids that do not have explosive properties. | 29(13.6) | 184(86.4) |
| **3.** | **Using vermicides such as FIPRONIL** | **187(87.8)** | **26(12.2)** |
| | 3.1 A chemical respirator is worn because it is deadly if inhaled. | 26(12.2) | 187(87.8) |
| | 3.2 Hands are washed immediately after a chemical exposure because it is deadly if ingested. | 20(9.4) | 193(90.6) |
| | 3.3 Body protective clothing is used because it is dangerous when chemicals come into contact with skin. | 20(9.4) | 193(90.6) |
| | 3.4 Chemicals are prevented from leaking or flowing into water sources because they are very toxic to aquatic organisms and have long-term effects. | 27(12.7) | 186(87.3) |
| | 3.5 Chemicals are properly stored and transported according to the Manual for Chemical and Hazardous Substances Storage, Notification of the Department of Industrial Works, 2007 because a flash point is less than or equal to 60 °C and flammable. | 28(13.1) | 185(86.9) |
| **4.** | **Using aphicides and insecticides such as imidacloprid** | **184(86.4)** | **29(13.6)** |
| | 4.1 A chemical respirator is worn because they are toxic. | 20(9.4) | 193(90.6) |
| | 4.2 Hands are washed immediately after a chemical exposure because they are toxic. | 16(7.5) | 197(92.5) |
| | 4.3 Body protective clothing is used because they are toxic. | 19(8.9) | 194(91.1) |
| | 4.5 Chemicals are properly stored and transported according to the Manual for Chemical and Hazardous Substances Storage, Notification of the Department of Industrial Works, 2007 because a flash point is less than or equal to 60 °C and flammable. | 28(13.1) | 185(86.9) |
| **5.** | **Using insecticides such as carbosulfan** | **181(85)** | **32(15)** |
| | 3.1 A chemical respirator is worn because it is deadly if inhaled. | 15(7.0) | 198(93.0) |
| | 3.2 Hands are washed immediately after a chemical exposure because it is deadly if ingested. | 26(12.2) | 187(87.8) |
| | 3.3 Body protective clothing is used because it is dangerous when chemicals come into contact with skin. | 20(9.4) | 193(90.6) |
| | 5.4 Chemicals are prevented from leaking or flowing into water sources because they are very toxic to aquatic organisms and have long-term effects. | 30(14.1) | 183(85.9) |
| | 5.5 Chemicals are properly stored and transported according to the Manual for Chemical and Hazardous Substances Storage, Notification of the Department of | 27(12.7) | 186(87.3) |

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| No. | Details in compliance with laws and SDS | Risk of exposure | |
|---|---|---|---|
| | | Yes Number (Percentage) | No Number (Percentage) |
| | Industrial Works, 2007 because a flash point is less than or equal to 60 °C and flammable. | | |

**Table 2. Results of the risk assessment levels on the use of agricultural chemicals in the community**

| No. | Details of the risks in compliance with laws and SDS | Risk assessment levels | | | Risk levels |
|---|---|---|---|---|---|
| | | Risk opportunity | Severity | Score | |
| 1 | Using aphicides such as abamectin | 4 | 2 | 8 | High* |
| 2 | Using maggoticides such as triazophos (Red Box), organophosphate (1B) | 4 | 2 | 8 | High * |
| 3 | Using vermicides such as FIPRONIL | 4 | 2 | 8 | High * |
| 4 | Using aphicides and insecticides such as imidacloprid | 4 | 2 | 8 | High * |
| 5 | Using insecticides such as carbosulfan | 4 | 2 | 8 | High * |

* Refers to a high risk that there must be an operation to reduce the risk according to the Regulation of the Department of Industrial Works regarding criteria for hazard identification, risk assessment and establishment of risk management plan (2000).

**Table 3. percentage and interpretation of the knowledge levels on pesticide use among farmers before and after the implementation of the safety program (n=213)**

| Knowledge levels on pesticide use among farmers using Bloom's criteria | Before | | | After | | |
|---|---|---|---|---|---|---|
| | N | % | Interpretation | N | % | Interpretation |
| Below 60% (less than 12 points) | 74 | 34.7 | Low | 1 | 0.5 | Low |
| 60-80% (12-16 points) | 56 | 26.3 | Moderate | 12 | 5.6 | Moderate |
| Over 80% (higher than 16 points) | **83** | **39.0** | **High** | **200** | **93.9** | **High** |

**Table 4. Number, percentage and interpretation of the attitude levels towards pesticide use among farmers before and after the implementation of the safety program (n=213)**

| Attitude levels towards pesticide use among farmers | Before | | | After | | |
|---|---|---|---|---|---|---|
| | Number | % | Interpretation | Number | % | Interpretation |
| 1.00 – 1.67 | 2 | 0.90 | Low | 1 | 0.5 | Low |
| 1.68 – 2.35 | **147** | **69.0** | **Moderate** | 16 | 7.5 | Moderate |
| 2.36 – 3.00 | 64 | 30.1 | High | **196** | **92.0** | **High** |

**Table 5. Number, percentage and interpretation of the self-protective behaviors in pesticide use among farmers before and after the implementation of the safety program (n=213)**

| Self-protective behaviors among farmers | Before | | | | After | |
|---|---|---|---|---|---|---|
| | Number | % | Interpretation | Number | % | Interpretation |
| 1.00 – 1.67 | 10 | 4.70 | Low | 1 | 0.5 | Low |
| 1.68 – 2.35 | **119** | **55.90** | **Moderate** | 7 | 3.3 | Moderate |
| 2.36 – 3.00 | 84 | 39.40 | High | **205** | **92.0** | **High** |

**Table 6. Results of the comparison of the differences before and after implementing the safety program according to the safety theory**

| Variables | $\bar{x}$ | | Mean Diff. | 95%CI | t | *p*-Value | *Sig.* |
|---|---|---|---|---|---|---|---|
| | Before | After | | | | | |
| Knowledge | 13.75 | 19.19 | 0.32 | 4.81-6.52 | 17.01 | 0.43 | ≤0.001* |
| Attitudes | 2.25 | 2.74 | 0.02 | 0.45-0.54 | 20.21 | 0.25 | ≤0.001* |
| Behaviors | 2.37 | 2.77 | 0.03 | 0.33-0.46 | 11.63 | 0.10 | ≤0.001* |

*** A statistical significance at the 0.01 level**

**Table 7. Number, percentage and interpretation of the satisfaction levels on the design of a chemical fume hood and a manual for chemical use in the community (n=213)**

| Satisfaction on the design of a chemical fume hood and a manual for chemical use in the community | n =213 | | |
|---|---|---|---|
| | Number | % | Interpretation |
| 1.00 – 1.67 | 0 | 0 | Low |
| 1.68 – 2.35 | 54 | 25.3 | Moderate |
| 2.36 – 3.00 | **159** | **74.7** | **High** |

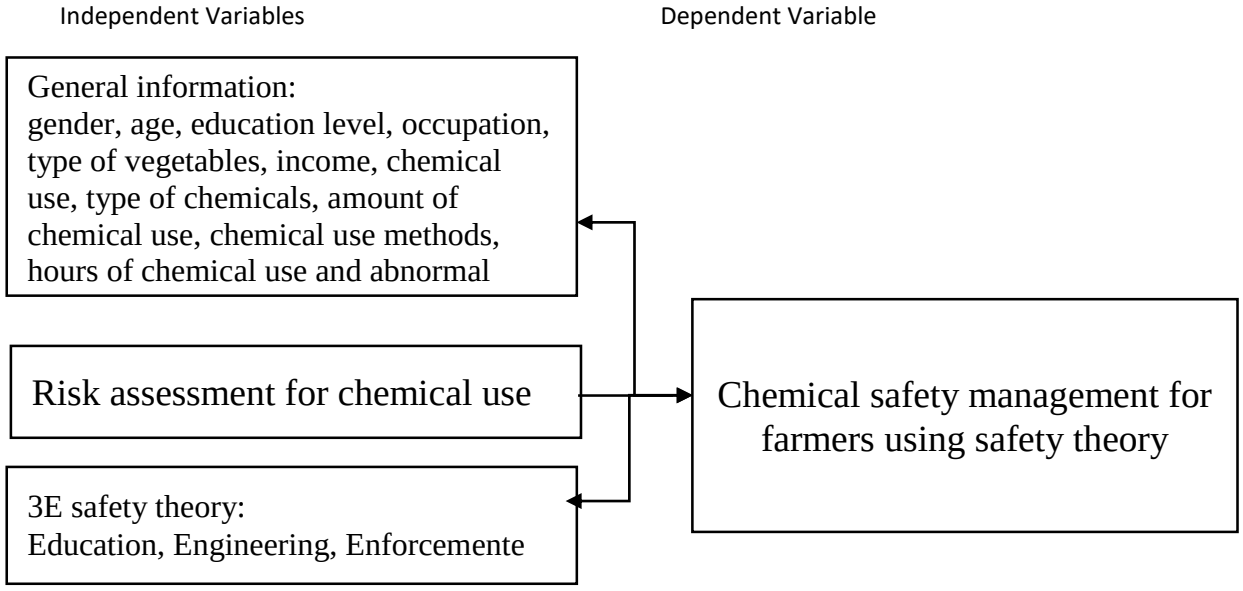



**Figure 1. Conceptual framework**

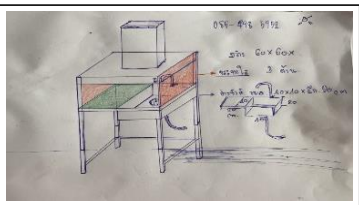
| | | |
|---|---|---|
|  |  |  |
| A collaborative meeting to design research and a chemical fume hood with community | Results of the participation in the design of a chemical fume hood | Results of the development of a chemical fume hood model |
|  |  |  |
| A follow-up meeting on a chemical fume hood and a manual with community participation | Results of participatory development of a chemical fume hood model | Development and labeling of safety signs on a chemical fume hood |
|  |  |  |
| Measurement of chemical vapors by Air Velocity Meter (Model 9515) | A chemical fume hood with the air speed of 0.31 m/s *ACGIH standard is 0.25-0.5 m/s | A meeting to provide a chemical fume hood and a manual for chemical use in the community to the community |

**Figure 2. The table of the design process of a chemical fume hood and a safety manual**