

Pesticides Usage Behavior and Health Impact of Thai's Farmers under Good Agricultural Practices System

Tasuku Koizumi¹, Hideo Hasegawa*² and Napat Kamthonsiriwimol³

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Summary

The significant problem of human illness and death that follows occupational and accidental exposure to pesticides has been well documented from several middle income countries due to the misunderstanding and lacking of an opportunity to have a training of the users. To evaluate the Good Agricultural Practices (GAP) standard's impact on reduction of pesticide poisoning, pesticide usage knowledge, protective measures and health conditions, in December 2014 we surveyed 33 farmers in Nakhon Sawan Province, Thailand through questionnaires and personal interviews. The results of the test questionnaire dealing with understanding pesticide use indicated there were no significant differences in knowledge between the GAP-certified group and the non-certified group. Although 75.8% of respondents reported always using protective equipment, 36.4% of GAP certificate holders and 40.0% of non-GAP certificate holders reported health problems and there was no significant difference between the two groups for percentage of respondents reporting health. Several health concerns, such as vertigo and respiratory problems, were observed. We estimated that these problems were caused by use of several highly toxic chemicals that are banned in other countries with insufficient eye protection during pesticide application. We cannot find evidence in this study to show that GAP practices had positive effects on farmers' health, and found weakness of hazardous substance regulation by Q-GAP certification. Promoting crop export and compliance with pesticide management rules in other countries may possibly lead to the establishment of new standards based on global regulations, while simultaneously improving domestic safety. And to recommend adequate personal protection of farmers, it is necessary to create access to proper protective equipment for farmers.

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Pesticides, including insecticides, herbicides and fungicides, are used intensively in modern agriculture for crop protection to minimize financial losses and maintain food supplies. Recently, world agriculture has been enhancing its reliance on the use of pesticides because of increased crop demand to satisfy global food supply requirements without expanding current land area used globally.

The use of pesticides, especially synthetic ones, poses risks to non-target organisms, including humans (Koh and Jeyaratnam, 1996). The significant problem of human illness and death following occupational and accidental exposure to pesticides has been well documented (Forget, 1991; Garcia, 1998). Schreinemachers et al. (2012) found that several middle-income countries^①, such as Brazil, Mexico, Uruguay, Cameroon, Malaysia and Thailand, showed a rapid increase in pesticide use. Adverse occupational exposures to pesticides

are especially common in these countries owing to lack of knowledge and training of users (Bull, 1982; Dinham, 1993). This gap in understanding and training opportunities may lead to improper pesticide usage behavior by farmers.

Cases of toxic effects of substances reported during 2007-2013 were found predominantly in the central region of Thailand, with about 15,262-22,035 cases each year (31-36% of total cases), followed by the northeast region (27-31%); cases in the northern (18-20%) and southern (18-19%) regions were approximately equal (Tawatsin et al., 2015). Farmers showed symptoms of nausea, vertigo, skin rash and allergies, cancer and neurological diseases. Therefore, the Thai government has attempted to reduce the number of cases by promoting a Good Agricultural Practices (GAP) system to farmers throughout the country. Since 2004, the Ministry of Agriculture and Cooperatives, with technological support

¹ Graduate School of Science and Technology, Niigata University, Niigata 950-2181, Japan

² Institute of Science and Technology, Niigata University, Niigata 950-2181, Japan

³ Department of Farm Mechanics, Faculty of Agriculture at Kamphaeng Saen, Kasetsart University Kamphaeng Saen Campus, Nakhon Pathom, 73140, Thailand

^① This is one of the analytical classifications of the world's economies, revised from the World Bank based on estimates of gross national income (GNI) per capita for the previous year. As of 1 July 2015, low-income economies are defined as those with a GNI per capita, calculated using the *World Bank Atlas* method, of \$1,045 or less in 2014; middle-income economies are those with a GNI per capita of more than \$1,045 but less than \$12,736; high-income economies are those with a GNI per capita of \$12,736 or more. Lower-middle-income and upper-middle-income economies are separated at a GNI per capita of \$4,125 [4].

*Corresponding author: hsgw@agr.niigata-u.ac.jp

from the Food and Agriculture Organization of the United Nations (FAO), has promoted a public standard of GAP, known in Thailand as Q-GAP (Q for “quality”) (Amekawa, 2009). The Q-GAP guidelines are based on eight principles that cover a wide range of farm management issues, such as site selection and management, pesticide use, and water supply (Department of Agriculture, 2009).

To promote the GAP system, the government has provided training, auditing, and the issuing of certificates for farmers across Thailand. Because Q-GAP is fully managed by the government, it is expected to encourage participation of small-scale farmers and upgrade their agricultural practices. Therefore certificates are issued free of charge to farmers and are valid for 1 year for seasonal crops and 2 years for perennial crops (Schreinemachers et al., 2012). These efforts helped raise the number of participants to more than 212,000 as of 2010 (Schreinemachers et al., 2012).

However, it is difficult to argue that Q-GAP succeeded in reducing the number of cases of pesticide poisoning. It is unclear whether the number of cases decreased after its introduction. In addition, some farmers do not comply with the standard (Amekawa, 2009). Schreinemachers et al., surveying lychee producers in Chiang Mai Province, reported poor implementation of farm auditing, related to an overly rapid program expansion and a lack of understanding among farmers on the logic behind the control points in the standard and on alternatives given to farmers to manage their pest problems (Schreinemachers et al., 2012). Therefore, the current situation of pesticide usage behavior and its health impact on Thai farmers under the GAP system needs to be understood.

As demonstrated by Schreinemachers et al. (2012), orchards in northern Thailand are well studied because this area is famous for upland horticulture, which requires frequent pesticide application. To capture an accurate picture of circumstances in Thailand, it would be necessary to focus on another part of the country and different kinds of agricultural commodities. In this study, we focused on Nakhon Sawan Province, located upstream of the Chao Phraya Delta region, to describe a developed region as the agricultural site.

MATERIALS AND METHODS

The Nongkrot and Takeanluan communities of Nakhon Sawan (Fig. 1) were selected as study sites for this survey. Nongkrot (15° 44′ 02″ N and 99° 59′ 05″ E) is located on the western side of the province. The community is approximately 133.23 km² in area and comprises 15 villages. Its population is around 12,020. About 85% of the population is involved in agriculture. Rice and vegetables are the important crops in this area. Takeanluan (15° 41′ 22″ N and 100° 03′ 58″ E) is in the southwestern part of the province, and to the west of the Chao Phraya River. It comprises 12 villages with an area of 20.73 km². Its population is approximately 6,104, 70% of whom are farmers. Bananas,

culantro, chili peppers, corn, and other vegetables and fruit are the main agricultural products in this area.



Fig 1. Location of Nakhon Sawan province
http://n.freemap.jp/tw/20150311_10553151037

The survey was conducted in December 2014. To achieve the objectives of our study, we combined quantitative and qualitative methods. To collect quantitative data we distributed questionnaire surveys to 33 randomly selected farmers from the two communities; In total, 45.5% of the respondents were in the 46–55 age group, followed by those in the 36–45 age group (24.2%), and the 56–65 age group (18.2%). Of the respondents, 54.5% had completed primary school and 27.2% had at least graduated junior high school; only 3.0% had no formal education. The respondents cultivated mainly rice (58.1%), bananas (25.9%) and culantro (22.6%). The average area per holding was 35.30 rai (5.65 ha). Most respondents were the landowners (39.4%), while others were farmers who partially rented the land (33.3%) or farmers who completely rented the land (27.3%). The respondents who had 5–15 years of experience in crop production comprised the majority in this study (36.4%), followed by 16–25 years of experience (24.2%). However, most had only very brief experience with GAP, having been involved with the program less than 5 years (66.7%); 45.5% of farmers earned less than 15,000 baht per month (average monthly income per household in Thailand was around 25,194 baht in 2013 (Schreinemachers et al., 2012)) regardless of GAP participation status. In contrast, 42.4% earned more than 30,000 baht. All respondents used chemical pesticides regularly. Overall, 78.8% used four or five different pesticides in one season, while 18.2% used only one pesticide.

The questionnaire mainly addressed two topics. First, we aimed to examine the understanding related to chemical pesticide usage through 16 true-or-false questions (Table 1). The difference of understanding levels between the GAP-certified group (n=23) and the non-GAP certified group (n=10)

Table 1. Description of understanding about protection test**Test description**

1. Chemical pesticides have merits and demerits.
2. Chemical pesticides are more effective than organic substances.
3. It is necessary to read the instructions on label before use every time.
4. Users could add more pesticide when mix in the container before spraying to make sure that all pests and insects would be eliminated.
5. It is not necessary to wear gloves, masks and use sticks when mix pesticides.
6. Mixing chemicals must not be done in windy condition to prevent spreading.
7. It is necessary to observe the wind direction in order to spray the pesticide in windward direction.
8. Users could apply the pesticides to the crops whenever they have time.
9. Continuous use on the same kind of pesticide for a long time could decrease outbreaks of insects.
10. The pesticides could exposure into a body through mouse, nose and skin.
11. If the user has a wound, the pesticides could exposure through a wound into a body faster than normal condition.
12. Users must wear long pants, long sleeves, masks or clothes that are capable to cover noses and mouth, gloves, goggle, hats and boots when they are spraying the pesticides.
13. After the users finished the spraying, it is possible to wash the sprayer and container in water supply.
14. Used pesticide containers are possible to dispose with plastic bottles after clean with water.
15. Users should drink a lot of water after the pesticides exposure to their body.
16. Users could drink the liquor to eliminate toxicity after the pesticides exposure to their body.

was evaluated through comparison of total scores. Second, we aimed to describe the farmer's health condition. We surveyed the physical and mental conditions of the respondents in relation to pesticide usage, and the impact of pesticides usage on those around them. A five-point hedonic scale was applied to indicate the degree of each symptom's occurrence: 1 (rarely), 2 (little), 3 (moderately), 4 (highly) and 5 (extremely).

In addition to the questionnaire, we conducted qualitative observations of workers' protective equipment and the selections available at the retail shop in the village, which was the main dealer of chemicals and protective equipment.

RESULTS AND DISCUSSION

Table 2. shows results of the test questionnaire dealing with understanding pesticide use. Most respondents had high awareness of chemical pesticides' risks. As evaluated by t-test, there was no significant difference in knowledge between the GAP-certified group and the non-certified group ($p = 0.658$, 2-tailed). The respondents possessed a good understanding of the advantages and disadvantages of the pesticides, and knew the correct way to protect themselves from the pesticides' effects by wearing protective gear. All

of them self-reported that they always read the information and suggestions on the labels before using the chemicals. However, percentages of correct answers were lower than 50% in the following three questions: Chemical pesticides are more effective than organic substances (48.5%); pesticides can enter the body through the mouth, nose and skin (3.1%); users should drink ample water after inhaling or swallowing pesticides (39.4%).

Fig. 2. summarizes results of the survey dealing with health conditions and impact of pesticide use. Overall, 36.4% of GAP certificate holders and 40.0% of non-GAP certificate holders reported health problems. According to Fisher's exact test, there was no significant difference between the two groups for percentage of respondents reporting health problems ($p = 1.00$, two-tailed). Scores of all symptoms surveyed were lower than 4. Several symptoms, such as vertigo (3.37) and respiratory system problems from the smell of chemicals (3.13) were common to many of the respondents.

In all, 75.8% of respondents reported always using protective equipment, 21.2% reported occasional use, and one respondent reported that he never used protective equipment. Fig. 3. shows an example of protective gear – a fully covered body with only the eyes exposed. Most respondents (62.5%) acquired pesticides in the village retail

Table 2. Results of the understanding about pesticides use test

	N	Mean	S.D	P value both side
GAP certified	23	11.39	2.52	0.658
GAP non-certified	10	11.70	1.42	

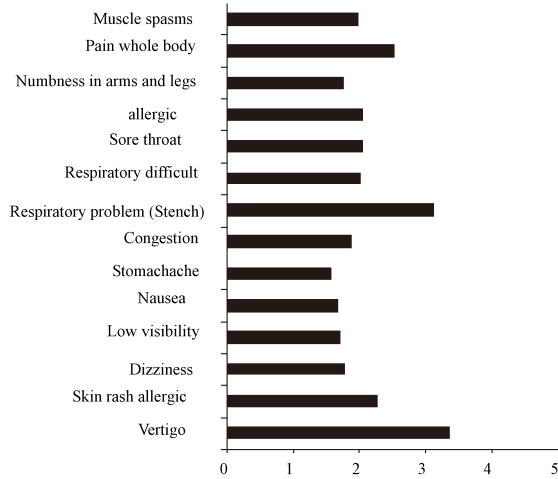


Fig 2. Farmer's health conditions

shop. Our survey indicated that the shop sold one type of gloves (25 baht) and one type of mask (10 baht); however, eye protection, such as goggles or safety glasses, was not available. Farmers had to go outside the village to seek these items.



Fig 3. Instance of farmer's protection

In the study area, we confirmed the use of following pesticides: the herbicide paraquat dichloride, the insecticide abamectin, and the fungicides azoxystrobin and difenoconazole. Paraquat dichloride, under the trade name Gramoxone, is a non-selective herbicide holding the largest share of the global herbicide market. It is banned in 36 countries because of its high toxicity, but not in Thailand

(Watts, 2012). Paraquat causes intoxication in animals and renal failure and lung damage in humans (Clark et al., 1996). Ingesting a substantial quantity of paraquat results in multiple organ failure, and death may follow within hours (Vale et al., 1987). In this study we did not observe such acute poisoning effects, however the effects of long-term repeated exposure cannot be ignored. Reported cases of respiratory problems in this study were possibly related to lung fibrosis caused by paraquat. Another highly recorded symptom in this study was vertigo, which is caused by abnormalities in the nervous system, especially in the brain stem, cerebellum, and cerebral hemisphere (Shami and Sanosi, 2011). Therefore, occurrence of vertigo is probably related to the use of neurotoxic chemicals. Abamectin may have caused this symptom, as it is known to be an agonist of receptors located in the postsynaptic dendrites of the central nervous system in many animal species (Sanchez-Bayo, 2012). Organophosphorus and carbamate pesticides are also neurotoxic; although they were not used by the farmers in our study, their use is widespread worldwide.

Looking at these results comprehensively, we cannot find evidence in this study to show that GAP practices had positive effects on farmers' health. There were no significant differences in knowledge levels and health conditions of the GAP-certified group and non-certified group, though the sample size may have been too small for detecting significant differences. Despite the farmers' literacy and awareness of the risks associated with pesticides, their protection was inadequate, and approximately 40% of respondents reported health problems such as vertigo and respiratory system concerns. Nevertheless, it is unclear whether these symptoms were caused by their pesticide use behavior. Our survey was conducted only once and during a short period. Considering that health conditions differ by the time of year selected, as temperature and weather conditions vary, if the survey were conducted in the spring or summer, the symptoms reported on the health condition survey would possibly be different. Therefore, replicated studies using a much larger sample size in different seasons would be required to detect health effects more accurately. In addition, medical tests may be required to clarify the relationship between these self-reported results and chemical exposure.

One problem we observed in this study was that farmers used several highly toxic chemicals that are banned in other countries. Q-GAP control points for food crops state that possession of pesticides prohibited under the Hazardous Substances Act (HAS) ^② B.E. 2535 (1992) was not allowed (National Bureau of Agricultural Commodity and Standards, 2013). However, as we saw that Gramoxone was freely used, HAS' s regulatory system may be difficult to enforce. Panuwet et al. pointed out that broad inclusion of vastly different chemicals made full compliance difficult (Panuwet et

^② The primary legal instrument aimed to regulate the import, production, marketing, and possession of all hazardous chemicals used in Thailand. The governing body is the Hazardous Substance Committee, which has assigned various aspects of governance to three ministries: Ministry of Industry, Ministry of Public Health, and Ministry of Agriculture and Cooperatives [18].

al., 2012). Thus, hazardous substance regulation by Q-GAP certification is not possible, because Q-GAP is a public standard based on governmental systems with limitations and weaknesses. However, farmers producing food for export to countries that ban certain pesticides follow their requirements not to apply the banned pesticides to the crops (National Bureau of Agricultural Commodity and Standards, 2013). Therefore, promoting crop export and compliance with pesticide management rules in other countries may possibly lead to the establishment of new standards based on global regulations, while simultaneously improving domestic safety.

Another problem was the farmers' inadequate personal protection. Considering that ocular protective equipment was not available for sale in the retail shop in the villages, where the majority of respondents acquired their pesticides, they did not have access to comprehensive protection. This indicates the important point that communication of knowledge and training in methods must be coupled with access to proper equipment for safe use of synthetic pesticides. Previously, organizations focused on the importance of educational programs and training for farmers as the measure of safe pesticide use. However, farmer training is useless without access to proper protective equipment. Thus, the key to safe pesticide use by farmers is easy access to such equipment. An alternative measure could involve the private sector, encouraging the distribution of appropriate protective equipment. A third measure could be to lower pricing for these items, making it possible for low-income workers to acquire and use them regularly.

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新興国における Good Agricultural Practice 認定者の農薬取扱い方法と健康被害に関する研究 —タイ, ナコンサワン県を事例として—

小泉 扶¹・長谷川英夫^{2*}・ナパット カントンシリウイモン³

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要 約

農作業者の知識の不足に起因する農薬の誤使用による健康被害が、世界の中所得国を中心とした国々から報告されている。Good Agricultural Practice (GAP) の認証の普及が農作業者の農薬の取扱いに関する知識の向上に寄与し、農薬による中毒の削減や農作業者の健康を守ることが期待されている。その効果を評価するため、タイにおいて Q-GAP の認証を得ている農家に対して農薬の扱い方や、中毒症状の有無、GAP 取得後の農薬に対する考え方や知識の変化等に関して聞き取り調査を行った。調査は2014年の12月に実施し、ナコンサワン県の農家33人を対象とした。農薬の取扱いに関する知識を問う検査の結果、GAP 取得者と未取得者の間に有意な点数の差は確認されなかった。また、全調査対象者の75.8% が農薬の散布時には常に防護装備を身に付けると回答していたのに関わらず、GAP 取得者の36.4%、未取得者の40% が何等かの健康障害があると回答しており2集団の割合に有意な差は認められなかった。特に空間識失調性のめまいや、呼吸器系の障害の報告が顕著であったが、これは国によっては使用が禁じられているような毒性の強い農薬が使用されていたこと、農薬散布時の眼部の保護が不十分であることによると推察した。本調査では GAP が農業者の健康の保護に及ぼす影響は薄く、Q-GAP の危険物質の取扱い規制の脆弱性が確認された。この課題に対しては、農産物の海外輸出を促進することにより、他国の農薬規制に合致する新しい基準の形成を推進することが有効であると考えられる。合わせて適切な防護装備に対する農業者のアクセスを改善することも重要である。

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¹ 新潟大学大学院自然科学研究科

² 新潟大学自然科学系

³ カセサート大学カンペンセン校農学部農業機械学科

* 代表著者：hsgw@agr.niigata-u.ac.jp