Impacts of Vietnamese Good Agricultural Practice (VietGAP) Criteria on Cabbage Farmers' Pesticide Risk in Hanoi, Vietnam

ผลกระทบจากแนวทางการเกษตรที่ดีของเวียดนามต่อความเสี่ยงจากสารเคมีของเกษตรกรผู้ผลิตกะหล่ำในฮานอย เวียดนาม

Nguyen Thi Phuong* Dr.Kampanat Pensupar (ดร.กัมปนาท เพ็ญสุภา)**

ABSTRACT

VietGAP standards are a new direction in Vietnam's agriculture development since 2008 in which reducing the pesticide risk for farmers is one of the core contents. Through the farmers' pesticide risk indicator (EI-farmer), was calculated based on the environmental impact quotient model (EIQ), the results showed that the VietGAP criteria on safe pesticide use including using pesticide right time, selection of less toxicity pesticide and followed the advice of the pesticide staff have a positive impact on the reduction of farmers' pesticide risk, in addition, factors such as agricultural labor, the number of pesticide training days also have a significant impact on reduction of Cabbage farmers' pesticide risk. The study recommended providing more pesticide training and extension workers, the criteria should be followed strictly to minimize the risk.

บทคัดย่อ

เวียดนามได้นำแนวทางการเกษตรที่ดีของเวียดนาม (VietGAP) มาใช้ในปี 2008 อันเป็นส่วนหนึ่งของการพัฒนาการเกษตรเพื่อลดปัญหาที่สำคัญของเกษตรกรผู้ปลูกกะหล่ำชาวเวียดนาม คือ ความเสี่ยงจากการใช้ยาปราบศัตรูพืช ทั้งนี้การศึกษาได้ทำการวิเคราะห์ดัชนีชี้วัดความเสี่ยงจากการใช้ยาปราบศัตรูพืชของเกษตรกร (Pesticide risk indicator) ซึ่งวิเคราะห์ภายใต้แบบจำลองของผลกระทบต่อสิ่งแวดล้อม

ผลการศึกษาชี้ให้เห็นว่า VietGAP ช่วยลดสารพิษจากการใช้ยาปราบศัตรูพืชภายใต้การแนะนำของเจ้าหน้าที่และเวลาที่เหมาะสม นอกจากนี้ยังพบว่าปัจจัยต่างๆ เช่น แรงงานเกษตร จำนวนวันที่อบรมในการใช้ยาปราบศัตรูพืช มีผลกระทบต่อการลดความเสี่ยงจากยาปราบศัตรูพืชของเกษตรกรที่ปลูกกะหล่ำอย่างมีนัยสำคัญ

ข้อเสนอแนะที่ได้จากการศึกษาเห็นควรให้มีการเพิ่มเวลา/ หลักสูตรการฝึกอบรมให้แก่เกษตรกรและเจ้าหน้าที่ส่งเสริมการเกษตรจะต้องติดตามการใช้ยาปราบศัตรูพืชของเกษตรกรอย่างเคร่งครัดเพื่อลดความเสี่ยงดังกล่าว

Keywords: VietGAP, Cabbage production, Pesticide risk

คำสำคัญ: แนวทางการเกษตรที่ดีของเวียดนาม (VietGAP) การผลิตกะหล่ำ ความเสี่ยงของยาปราบศัตรูพืช

* *Student, Master of Science Program in Agricultural and Resource Economics, Faculty of Economics, Kasetsart University*

** *Assistant Professor, Department of Agricultural and Resource Economics, Faculty of Economics, Kasetsart University*

Introduction

Vegetable production has a very important role in economic development, especially economic development in rural Vietnam. However, along with the development, vegetable production is facing the major problem, there are overuse and improper use of pesticides by farmers, especially in Cabbage production. Since 1950, Vietnam began imported and used pesticides in agricultural production. The volume of imparted pesticide was increasing rapidly during last year, and up to 116.5 tons in 2014 by Vietnam Environment Administration (2015) and increased from 5 kg/hectares (ha) in 2003 to 16 kg/ha in 2012 (Schreinemachers *et al.*, 2013). Pesticide imported values was increased significantly in the overtime (Trademap, 2016) while 99% of pesticide used is imported in Vietnam. Notably, most of pesticide imported came from China with low price, it is mean that pesticide use in Vietnam by farmers is low quality, it really is serious for human health and the ecosystem. Besides, the improper use of pesticide is a quite serious problem by Vietnam farmers (Van Hoi, *et al*., 2009). Many studied shown that the improper and overuse of pesticide in vegetable production were caused significant pesticide risk to farmers. Vegetable growers, who have prolonged and direct contact with pesticides have faced high risk, as a result, overuse and high toxicity level of pesticide were increasing pesticides risk for farmers-self.

In the context, Vietnam government issued a policy that is Vietnamese good Agriculture practice (VietGAP) in vegetable and fruit production since 2008. The purpose of VietGAP are improving food quality, food safety, protecting worker health, consumers' health, improving social welfare, protecting the environment, and ensuring product traceability base on preventing and minimize the risk of hazard which occurs during production, harvesting and post-harvest handling (Nicetic *et al.*, 2016). To achieve these objectives, the core content of VietGAP is safe pesticide use. It is then important to minimize the potential risk of pesticides by selecting pesticides with the low toxicity level to pesticide risk reduction for farmers like using limited pesticide, using environment-friendly pesticide and properly using followed recommended product.

Hanoi is a main vegetable region of Vietnam with 12.000 ha vegetables area in 2016 equivalent to 30.000 hectares vegetable planted area per year. Since 2008, Ministry of Agriculture and Rural Development of Vietnam (MARD) was selected Hanoi such as a pilot local for VietGAP program and becoming one of leading city of VietGAP and one of the first vegetables was selected to pilot this program that was Cabbage. Theoretically, farmers who participated VietGAP program, they are gain pesticide knowledge through training courses lead to changing their behavior and finally is pesticide risk reduction. However, in the fact adopted level of VietGAP criteria is different among farmers *(*Loan *et al.*, 2016*).* Question is whether VietGAP farmers are pesticide risk lower than conventional farmers, and how is effect of VietGAP criteria in pesticide use on farmers*'* pesticide risk? This paper discusses the status of farmers' behavior in pesticide use toward VietGAP standard and its impact on farmers' pesticide risk in Cabbage production in Hanoi, Vietnam.

Methodology

Selection of study sites

This survey was conducted 3 districts including GiaLam, Thanh Tri, and Chuong My district because they are main Hanoi's Cabbage area. Addition, Gia Lam, and Thanh Tri are two districts where were chosen to practice pilot VietGAP standard by Vietnam MARD, and Chuong My was representative for follower group. According to the criteria, as a result, Dang Xa and Van Duc communes of Gia Lam district and Yen My commune of Thanh Tri district were seltected as leader commune in VietGAP vegetable production since 2008 while Chuc Son of Chuong My was representative for followed group.

Sampling size of study and sample size in each commune

The research investigated the behaviour of farmers belonging two groups following farmers who are VietGAP adoption and having certificate for VietGAP vegetable and farmers who are non-VietGAP adoption. Based on Roscoe (1975) who conceptualized the rules of thumb for determining sample size, sample sizes larger than 30 and less than 500 are suitable for most research. Hence, to minimize sampling bias, a total of 300 farmers have been selected to survey including 150 for adopter and 150 for non-adopter. A number of samples in each commune are proportional with total number of households in that commune as specification (table 1).

Table 1: The sample distribution in Hanoi, Vietnam

District	Commune	VietGAP areas (ha)*	Total Adopter**	Adopted Farmers	Non-adopted farmers	Sample
Gia Lam	Van Duc	14.6	227	62	62	134
	Dang Xa	10	100	28	28	54
Thanh Tri	Yen My	11	110	30	30	60
Chuong My	Chuc Son	14.7	108	30	30	60
Total		-	**545**	**150**	**150**	**300**

Source: (*) Vietnam information Research Center (2017), (**) secondary data from unpublished commune reports, key informant interviews in the studied communes

The empirical data was collected in face-to-face interviews from the respondents by a questionnaire. To ensure exactly farmers' respondents about types of pesticide which farmers used in early Cabbage season in 2017, a pesticide picture list that collected in all pesticide shop at the local was used as a tool to support farmers in determination particular pesticide

Data analysis

Descriptive statistics method is used to quantitatively provide the mainly characteristics of sample and report on farmers' behavior in safe pesticide use by two groups. Besides, interviewers classified their behavior following each

criterion to determine whether they have implemented the criterion correctly or not. Table 2 presented details how to determine farmers' behavior following each criterion.

Table 2. Farmers' practice criteria definition toward VietGAP in pesticide use

No	Criteria	Description
1	Farmer have been trained to a level appropriate to their area of responsibility for chemical use	1 = Yes If farmers had attend training and having trained certificate; 0 = Otherwise
2	Farmer have to use right time for the crop	1 = Yes If farmers only allowed to use pesticides at the right time. This means that farmers only use the pesticide when there are signs of pest or disease development; 0 = Otherwise
3	Did not use high hazard pesticide *(*Class I &II*)*	1= Yes If farmer who only used class III and class IV of pesticide during the season; 0 = otherwise
4	Using chemical products needs to be made by an consulted adviser	1= Yes for farmers who selected and used new chemical pesticide by a advice from pesticide staff at the local; 0= Otherwise
5	Chemicals and bio-pesticides used on crops are approved by a competent authority in Vietnam	1 = Yes for farmers who read and checked pesticide permitted list before use; 0 = Otherwise
6	Reading instruction before use	1 = Yes if farmers who read all information to practice or at least 4 of the whole main information *(*name, dose, pre-harvest interval day, toxic level or warning signs**)** 0= Otherwise
7	Right the best time for pesticide handling practice	1= Yes if when spraying nozzle ensures always kept under the wind, and spray at early dry morning and cool afternoon; 0= Otherwise
8	Using full protective equipment during pesticide handling	1 = Yes for if farmer use at least 5 of 6 equipment *(*a hat, boots, mask, glasses, rain coat and gloves*)* during spraying; 0 = Otherwise
9	Withholding periods for the interval between pesticide application and harvest are observed according to label directions	1 = Yes If farmers who provide exactly the last pesticide name and periods before harvesting, interviewer would check and contrast with that label if it was correct then farmer followed.; 0 = Otherwise
10	The application of pesticide is recorded for each crop	1 = Yes if farmer who often record keeping all information as requirement *(*name, reason for use, date, dose, withholding period*)* followed this criterion; 0 = Otherwise

Measure farmers' pesticide risk

Pesticide risk is contributed by two components hazard and exposed, as stated in the equation below:

Risk = Hazard x Expose

A hazard is the potential for harm or an adverse effect for people and the environment of pesticide, exposure to a hazardous pesticide would cause disease or some incidence causing damage for health and the environment. Thus, pesticide risk is estimate by Environmental Impact Quotient (EIQ) (Kovach *et al.*, 1992) as a rating system to assess the environmental impact. It generalizes a wide range of potential impacts on farm workers, consumers and the environment based on toxicological data, chemical properties and physical behavior (FAO, 2008). Table 3 shows EIQ component and formula (Kovach *et al.*, 1992).

Field use EIQ is an indicator of risk of specific pesticide applications in crop production. This indicator was employed to estimate the hazard of the product concerned and to provide an indication of potential pesticide risk. Field use EIQ was calculated as multiplying the table EIQ value for a specific active ingredient by the percent active ingredient in the formulation and its dosage rate per hectare used (in liter or kilogram of formulated product). However, this study just focused on pesticide risk of farmers, it is composed of pesticide hazard and exposure level by formula (1).

Table 3: EIQ component and formula

<table>
<tr><td>EI Applicator: C *(DT*5)</td><td rowspan="2">EI farm worker =
EI sprayer +EI picker</td><td rowspan="8">EIQ = (EI farm worker + EI consumer + EI Ecology)/3</td></tr>
<tr><td>EI Picker: C *(DT *P)</td></tr>
<tr><td>EI consumer: C *((S +P)/2) *SY</td><td rowspan="2">EI consumer =
EI consumer + EI Ground water</td></tr>
<tr><td>EI Ground water: L</td></tr>
<tr><td>EI Fish: F*R</td><td rowspan="4">EI Ecology =
EI fish + EI bird +EI Honey Bee + EI Natural Enemies</td></tr>
<tr><td>EI Bird: D *((S+P)/2)*3</td></tr>
<tr><td>EI Honey Bee: Z*P*3</td></tr>
<tr><td>EI Natural Enemies: B*P*5</td></tr>
<tr><td colspan="3">Full formula:
EIQ = {C[DT*5)+(DT*P)] +[(C*((S+P)/2*SY)+(L)]+[(F*R)+(D*((S+P)/2*3)+(B*P*5)+(Z*P*3)]}/3</td></tr>
</table>

Among these, farmer risk value was determined as the sum of sprayer exposure (DT* 5) plus picker exposure (DT*P) times the long-term health effect or chronic toxicity (C) calculated and available to estimate field EI farmers by Kovach *et al*. (1992). % active ingrident and dose come from specific pesticide that was used during cabbage season.

Field Use EI *farmer* = EI *worker* value x% Active Ingredient x Dosage Rate (1)

Estimate impacts of VietGAP criteria in pesticide use on Cabbage farmers' pesticide risk

Multiple linear regression was used to consider the relationship between farmers' pesticide risk and criteria of safe pesticide use**.** They are expected that VietGAP criteria and pesticide risk have linear relationship**.** An application of one VietGAP criterion is lead to pesticide risk reduction**.** Besides, pesticide risk can be influenced by social-

economics characteristic. A multiple linear regression model used to estimate impact of each VietGAP criterion on pesticide risk with importance socioeconomic characteristic such as age, gender, education, farm size, household size (dependent and agriculture member). The model is estimated using the Ordinary least square (OLS) method:

$$Y_i = \alpha_0 + \alpha_1 x_{i1} + \alpha_2 x_{i2} + \ldots \alpha_p x_{ip} + \varepsilon_i \text{ for } i = 1,2, \ldots 300$$

Where,

Y is farmers' pesticide risk (continuous variable)

X is independent variable (including VietGAP criteria and socioeconomics of farmers)

α is marginal effect

Results

Main Characteristics of the Studied Communes

Dang Xa and Van Duc communes are located in Gia Lam district while Yen My is Thanh Tri district and Chuc Son belongs to Chuong My district in Hanoi city, Vietnam.

Table 4. Basic Information on Studied Communes

Criteria	Gia Lam		Thanh Tri	Chuong My
	Dang Xa	Van Duc	Yen My	Chuc Son
1. Population (person)	9481	8000	6800	9254
2. Number of households (household)	2104	2000	1500	2050
Percentage of Farm households in total (%)	92.5	100	86.67	87.8
Averaged household size (person)	4.51	4.0	4.53	4.51
3. Agricultural land				
- Cultivated land (ha)	245.8	655.23	159	240
- Averaged farm size (m2)	1119	819.03	1676.1	1170
- Total vegetable areas in the commune (ha)	120.0	250	90	80
Total VietGAP vegetable areas in the commune (ha)	10	14.5	21	15
4. Number of vegetable farm households (hh)	1400	2000	800	900
5. Number of villages producing vegetables (village)	10	3	3	7
6. Cabbage areas in the commune (ha)	20.0	100	50.5	50

Source: Secondary Data from unpublished commune reports, key informant interviews in the studied communes during October and November 2017

Population of each commune fluctuated from 6800 people in Van Duc to 9481 people in Dang Xa commune and about 1500 to 2104 households with average household size of 4.0 to 4.53 persons (Table 4). All of the communes are agriculture location with around 87% of Yen My and Chuc Son, 92.5% for Dang Xa, especially 100% in Van Duc

commune. Among these, vegetable areas have from 30% agriculture land size in Chuc Son to 57% in Yen My communes. Agriculture areas in each commune is very high with the average farm size of 819 m2 to 1170 m2 (table 4). The number of vegetable households in each commune is very high with 800 households in Yen my (54%) and 100% in Van Duc commune. All farmers are considering vegetable growing activities as their mainstay. Among these, Cabbage was the main vegetable grown in each commune with 3 planting season starting from July to the end of March next year. During this time most of the household in each commune grows Cabbage.

Socio-economic Status of the Studied household

From table 5, we can see that the characteristics of the selected farmer. Among the 300 household respondents, there are 221 female and 79 female household heads in which having difference about gender from two groups, female household heads in VietGAP group is higher than that of conventional group. The average age of them are over 50 years old, the average household size is 4.63, mean of labor in household is 3.08 for non-VietGAP and 3.24 for VietGAP group, in which agriculture labor is 2.32 for non-VietGAP and 2.37 for VietGAP group, the dependent member in household of non-VietGAP is higher than that of VietGAP farmers.

Table 5. Characteristics of VietGAP Cabbage farmers in Hanoi, Vietnam, 2017

	Conventional farmers		**VietGAP farmers**			
Characteristic	**Mean**	**SDD**	**Mean**	**SDD**	**Overall**	**t-test**
Age (years)	49.99	6.5	50.53	6.9	50.26	ns
Gender	.69	.5	.79	.4	0.74	*
Education (years)	6.97	2.5	7.11	2.6	7.04	ns
Household size (people)	4.63	1.3	4.63	1.3	4.63	ns
Labor size (people)	3.08	1.0	3.41	.9	3.24	ns
Dependent member	1.59	.9	1.33	.9	1.46	ns
Agriculture member	2.32	.6	2.42	.8	2.37	ns
Farm size ($m^{2)}$	2137.20	649.76	2406.00	780.97	2271.60	*
Vegetable size ($m^{2)}$	1690.80	628.82	2139.00	727.69	1914.90	*
Cabbage farm size ($m^{2)}$	550.32	265.0	959.76	625.1	755.04	*
Vegetable income (mill VND)	91.34	43.15	131.33	53.55	111.33	*
Pesticide training (days)	10.92	6.5	22.63	10.9	16.77	*

Source: primary survey, 2017

Note: (*) are significant at 5%, ns is not significant at 5 % probability level.

However, the difference in labor and dependent member is not significant from two groups. The mean of education is 7 years and no having difference from VietGAP farmers and non-VietGAP farmers.

There are different about vegetable size and Cabbage farmer size from two groups, mean vegetable size of VietGAP household is 2139 m2, it was higher than that of conventional households with 448.2 m2. Similar, Cabbage farm size of VietGAP household is higher than that of non-VietGAP with 409.44 m2. Income from vegetable has a difference from two groups. Besides, the number of pesticide training days of VietGAP group is higher than those of conventional farmers and making a significant difference 11.71 days.

Farmers' Adoption on VietGAP criteria in safe pesticide use

Following principle on pesticide use, farmers are allowed to use pesticide when fields have problems with pests including forecasting issues and increased pest populations to action threshold. However, research found main reason for using pesticide that most of the studied farmers often apply pesticide weekly despite no sign of pest development. There were only 26.1% of non-VietGAP farmers using right principle while 51.3% of VietGAP farmers used correct principles in the use of pesticides including all farmers apply pesticide without application fix cycle (table 6). Although the number of VietGAP farmers followed this principle higher than that of traditional farmers but the rate remains too low. Half of VietGAP farmers still keep traditional methods so that pesticide abuse is still widespread in VietGAP production.

There were 48% of conventional farmers and 78% of VietGAP farmers reported reading the label of pesticide before use. This fact reflects an increment of 30% of VietGAP farmers compared with those of conventional farmers. There were more traditional farmers trusted extremely pesticide seller than those of VietGAP farmers, they still considered pesticide sellers as the main source of pesticide selection and use. Thus, they have never read the pesticide label before using them.

Table 6. Farmers' behavior in pesticide use

Criteria	Conventional farmers (B) (N = 150)	VietGAP farmers (A) (N = 150)	Difference (A-B)
Used right time for spraying pesticide (%)	26.1	51.3	**25.2**
Read the lable before use (%)			
Read	48	78	30
Didn'tt read	52	22	30
Check permitted list before use (%)	6.7	18	11.3
Using full protective equipment during spraying time (%)	9.3	18.7	9.4

Source: primary survey, 2017

It also was found that a number of VietGAP farmers checked pesticide in a permitted list that bought before using higher than those of conventional farmer making a difference with 11.3%. However, there were more than 80%

of VietGAP farmers didn't know about allowed pesticide list, this reflects that they didn't care about it because, in reality, they were provided that list by trainer, moreover, it is also displayed on fields as a big warning sign. Despite the requirement of VietGAP in safe pesticide use requirement, almost farmers still didn't care about this problem. Using protective equipment when spraying is one of the most important issues, all applicators always used protective tools during spraying time, however the fact showed that most of them only are used to wearing a hat and boots, only 9.3% of conventional farmers and 18.7% of VietGAP sprayers used 5 of 6 protective equipment including gloves, mask, boots, hat and glasses, no one used a raincoat as requirement of safe pesticide use rule. Farmer who didn't use enough protective equipment believed that today pesticides didn't have a smell as bad as those of before, mostly light so that they were safe in using. Moreover, the use of glasses, masks made them feel uncomfortable, raincoat was too hot to use

Farmers' behavior in pesticide use for Cabbage production

The result showed that the rate of insecticide was the highest in cabbage production, followed by fungicides and finally herbicides. However, it can see that the rate of herbicide used was negligible with nearly 1%. Although weed was a major problem for vegetable producers, there were few of them used herbicides in Cabbage production.

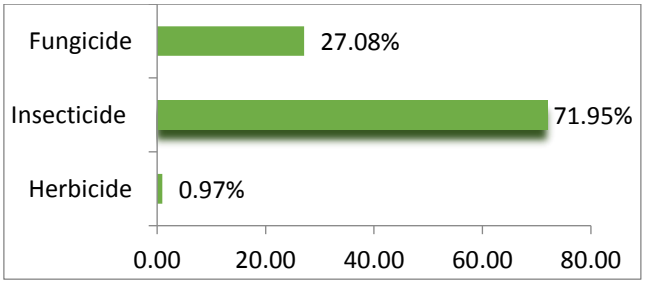

Figure 1. Pesticide classified by purpose

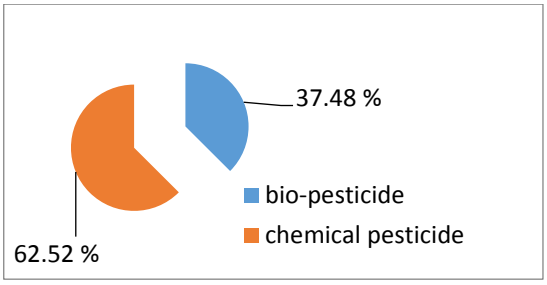

Figure 2. Type of pesticide classified by origin

Because according to their experience, after the use of herbicides the soil becomes malnourished. Plants will become difficult to grow and hard to care, therefore, they often apply a manual method to replace for chemical herbicide. Above 99% of farmers often apply to clear of weeds by their hands (figure 1). In term of the total pesticide that used, of which the 37% used was bio-pesticides and 63% of whole pesticides was chemical pesticides. As a result, Hanoi's farmers use mainly pesticides of chemical origin (figure 2). Among these the rate of VietGAP farmers used bio-pesticide higher than those of conventional farmers, and making a difference was 10.5% (table 7).

Table 7. Farmers' behavior in pesticide use for Cabbage production by groups

	Conventional farmers		VietGAP Farmers		Difference
Criteria	**Spraying times**	**Percentage (B)**	**Spraying times**	**Percentage (A)**	**Percentage (A-B)**
Type of pesticide used follow original					
Chemical pesticide	728	67.7	590	57.2	-10.5
Bio-pesticide	348	32.3	442	42.8	+10.5
Type of pesticide follow hazard level					
Class I	0	0	0	0	-
Class II	220	20.4	200	19.4	-1
Class III	624	58.0	591	57.3	-0.7
Class IV	232	21.6	241	23.4	+1.8
Average of sprays per farm	5.59		5.35		-0.24*

Source: primary survey, 2017

By WHO's toxicity class, pesticides are classified by four groups with highest toxic level is I and following is class II, class III and less toxic is class IV. It was found that in the total number of pesticide times to be used in Cabbage production, the numbers of pesticide class III and IV used in the whole farmers in Hanoi city were mainly. There was no significant difference between the two farmer groups. None of the farmers in both two groups used pesticide that belonged to toxicity class I.

Averaged number of sprays per farm was 5.59 for conventional group and 5.35 for VietGAP group (table 8). It was making a significant difference in the number of spraying times between two groups. There was not the same trend in minimum numbers of sprays per farm with 9 times for maximum and 3 times for minimum of VietGAP farmers while that of conventional was 9 times for maximum and 4 times for minimum.

Table 8. Farmers' adoption on VietGAP criteria in pesticide use

Variable		Conventional farmers N= 150	VietGAP farmers N=150
Number of farmers' practiced criteria (%)	1.0	4.7	0.0
	2.0	31.3	0.7
	3.0	30.0	12.7
	4.0	18.0	15.3
	5.0	13.3	22.0
	6.0	0.7	21.3
	7.0	2.0	10.0
	8.0	0.0	10.7
	9.0	0.0	6.0
	10.0	0.0	1.3
Mean of adoption		3.14***	5.61***
Adopted level (%)	**High from from 8 and above**	0	18
	Medium from 5 to 7	16	53.3
	Low from less than 5	84	28.7

Source: primary survey, 2017

Note: (***) are significant at 1%

Table 8 shows the extent of VietGAP adoption in Cabbage production by the number of adopted criteria by each farmer. Among these, there were only 2 farmers or 1.3% of the whole VietGAP farmers adopted strictly all safe pesticide use criteria. None of the conventional applicators followed strictly all these criteria for safe pesticide use. 18% of total VietGAP respondents applied 8 practices and above while the non-VietGAP group was nobody. 53.3% of total VietGAP respondents adopted from 5 to 7 practices or medium adopted level while there were only 16% of the traditional applicators followed these adopted level. Up to 84% of traditional farmers practiced less than 5 criteria and belong to a low application group. This fact reflects was a significant difference of conventional farmers, respectively as compared with those of VietGAP farmers with 28.7%, it was creating a difference 55.3% from two groups. In addition, there were significant differences in the average of safe pesticide use criteria with 3.5 criteria for the conventional group and 5.16 criteria for the VietGAP group.

Among these, Using right the best time for spraying criterion was the highest in the whole criteria in both two groups with 100% (figure 3), farmers knew that spraying in the early morning or late afternoon is the best for their health and ensuring that pesticide will not be evaporated due to high temperatures. Respected pre-harvest interval was the second mostly adopted practices with around 97% of total VietGAP adopters and 94% of whole non- VietGAP adopters. Applicators have been trained were highly adopted as well with 94.7% of total VietGAP adopters but that of

conventional adopters was quite lower with 23.3%. There were 51.3% of total VietGAP farmers adopted right time criteria and no used high hazardous level while those of non-VietGAP farmers were 28% and 26.8%, respectively. Besides, less commonly used criteria in both groups were reading the label before use, using chemical product needs to have advised from pesticide staff (figure 3). Noticeably, using protective equipment is an important issue to protect for themselves, however, only 18% of VietGAP farmers practiced correctly while that of conventional farmer group was 9%.

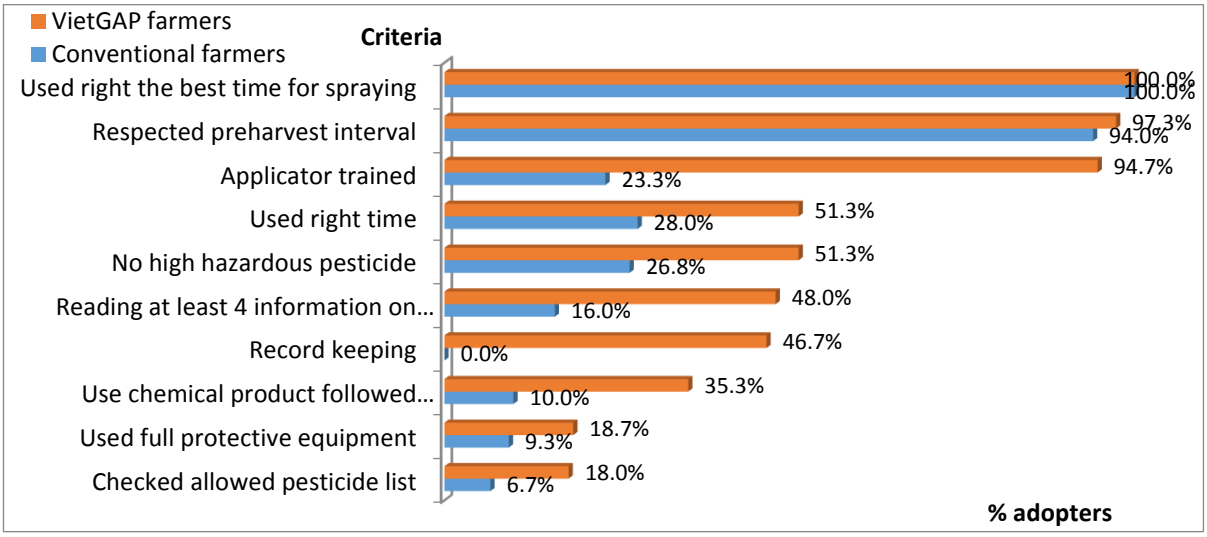

Figure 3: Farmers' adoption on VietGAP criteria in pesticide use by each criterion

For record keeping was a new activity for farmers, and the perception of households on this activity was limited, even some VietGAP households have not recorded, as a result, there were 48% of whole VietGAP households recorded and no one in conventional household followed this criterion.

In general, the VietGAP farmer group has practiced better in safe pesticide use than that of conventional farmers, but this is still limited.

Impacts of VietGAP criteria on Cabbage farmers' pesticide risk

The empirical results pesticide risk for Cabbage growers in Hanoi city is shown in table 9 below. The outcome indicates that many criteria significant impact on Cabbage farmers' pesticide risk. Among the explanatory variables considered, agriculture member in household, pesticide training days, using pesticide right time, none of the highly hazardous pesticides (belong to class I and II of chemical product), selection of chemical pesticide followed pesticide staff's instruction have positive significant impacted on reduction of farmers' pesticide risk as expected, which implies that if agriculture member in household, pesticide training days increase it would lead to a reduction of Cabbage farmer's pesticide risk. Farmers practice correctly principle of safe pesticide use on spraying pesticide right time, no selection of high chemical product and having the instruction of pesticide staff that will lead to decrease farmers' pesticide risk. Whereas some of the factor as farm size, a dependent member in household and the number of sprays

have negatively impacted on reduction of Cabbage farmers' pesticide risk. In this context, Cabbage farmers' pesticide would increase if farmer increases the number of sprays per farm in a season. Because the amount of pesticides use would increase lead to an increase in exposure of farmers. The number of dependent member in household increase leads to increasing of Cabbage farmers' pesticide risk. Because most of the respondents explained that they had to share their time, they spent more time taking care of them lead to decrease time for caring for vegetable. Similarly, increasing farm areas also causes them to share their labor hours so they have to use more pesticide instead of hiring labor to care for and track crops with a cheaper price.

Table 9. Estimated impacts of VietGAP criteria on farmers' pesticide risk

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	20.432	18.780		1.088	.278
	AGE	.145	.260	.035^{ns}	.557	.578
	GENDER	-2.338	3.224	-.037^{ns}	-.725	.469
	EDU	-.508	.672	-.046^{ns}	-.755	.451
	De_meber	3.497	1.613	.114**	2.168	.031
	Agri_member	-6.530	2.388	-.159***	-2.735	.007
	FARMSIZE	.009	.002	.239***	4.002	.000
	PTRAINING	-.365	.153	-.140**	-2.386	.018
	GAPVEGIN	-.169	.143	-.073^{ns}	-1.183	.238
	RIGHTIMEUSE	-9.621	3.240	-.169***	-2.969	.003
	FPSINTROTION	-6.702	3.897	-.101*	-1.720	.087
	NOHIGHHAZARD	-5.778	3.177	-.101*	-1.819	.070
	CHAPKLIST	-4.083	4.398	-.048^{ns}	-.928	.354
	RECKEEPING	-2.689	4.300	-.041^{ns}	-.625	.532
	UFULLPEQUI	-1.858	4.427	-.023^{ns}	-.420	.675
	NUMBEROFSPRAYS	3.333	1.256	.137***	2.654	.008
R Square	.311					
Adjusted R Square	.275					
Durbin – Watson	1.731					

Note:, **, *** significant at 10%, 5% and 1% levels, respectively, ns is non-significant*

Discussion and Conclusion

This study also focused on analyzing leading concerned VietGAP criteria in safe pesticide use on farmers' behavior and its impacts on Cabbage farmers' pesticide risk.

Based on performances of pesticide use activities in two farmers groups, it leads to a fact that VietGAP farmers have tended to change their pesticide use behavior compared to that of the conventional group, from using more chemical methods to being used more bio-pesticide or class III and class IV to control pests and disease, from never record keeping to record keeping, from spraying weekly cycle to being sprayed when field has pests. These are reflected in the number of farmers adopted these criteria and adopted level of each group. The study also showed that criteria on spraying pesticide right time, no selection of high chemical product and having the instruction of pesticide staff have positive significantly impacted in reduction farmers' pesticide risk.

However, the fact also reflects that the application level of the VietGAP farmer group is still not high. The low adoption level and the medium level of VietGAP farmer groups account for nearly 80% while they are required high levels of application. Therefore, even though they have met a number of requirements, they still do not perform well as required by VietGAP standards. Thus, in order to encourage cabbage farmers to reduce pesticide risk, the study recommended that Vietnam government should be providing more pesticide training for farmers and extension workers; farmers should be followed strictly the criteria such as used right time and no high pesticide selection as well as using the pesticide incase indispensable to reduce the number of sprays.

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