

## **LITCHI FARMERS' PREFERENCE FOR THE ADOPTION OF VIETNAMESE GOOD AGRICULTURAL PRACTICES IN LUC NGAN DISTRICT, VIETNAM**

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### **ABSTRACT**

Vietnam has great potential for litchi production and exportation, however, food safety standard is a significant challenge. In an effort to overcome this challenge, the Vietnamese government introduced the Vietnamese Good Agricultural Practices (VietGAP) for litchi farmers and considered it as a significant breakthrough for market accessibility and exportation of Vietnamese litchi. This study sought to explore farmers' attitude toward VietGAP, and the influence of VietGAP standard on adoption decision of litchi farmers in Luc Ngan district - the largest and most well-known litchi production region in Vietnam. A questionnaire-guided interview survey was conducted of 300 households covering those who adopted VietGAP and non-adopting farm households. The study revealed that most litchi farmers have a positive attitude toward different aspects of VietGAP litchi production and 88.7% of respondents perceived that VietGAP adoption is a sustainable practice for litchi production in the future. However, a significant number of non-adopters still expressed hesitation and doubts on the application of VietGAP. Choice experiments showed that requirements for pre-harvest fruit wrapping and monocropping, and price premium affected significantly farmers' adoption behavior while animal raising and pesticide standard were not a constraint for adoption. In addition, litchi farmers require a premium of between 16-60% of conventional litchi price for VietGAP adoption.

**Key words:** Choice experiment, farmer's attitude, food safety

### **INTRODUCTION**

Recent reports and studies show that demand for litchi has increased in the high-end markets such as Canada, Saudi Arabia, United Arab Emirates, United States, and Europe Union (Commonwealth Secretariat, 2001; Evans et al., 2005; Ghosh, 2001). Although Vietnam was listed among the top five litchi producing countries in the world (Evans et al., 2005; FAO, 2002), it has failed to penetrate these developed nations due to challenges in meeting quality standards. Consequently, 95% of the exported volume from Vietnam was to China over the recent decade with a low price (Vietnam Trade Promotion Agency, 2014b). In this context, Vietnam Ministry of Agriculture and Rural Development (MARD) introduced Vietnamese Good Agricultural Practices (VietGAP) litchi in 2008 in Luc Ngan district, Bac Giang province, which was considered as a

significant breakthrough for growers to fulfill high-end consumers' expectation about high quality litchi. Luc Ngan district has been best known as the predominant litchi production region of Vietnam with high annual outputs. Moreover, Luc Ngan litchi has been recognized as a traditional specialty and protected geographical indication (Vietnam Trade Promotion Agency, 2014b). In fact, VietGAP litchi in Luc Ngan was developed based on Global Good Agricultural Practices (GlobalGAP) including a set of criteria which aimed to produce clean and safe litchi. Apparently, VietGAP introduction enabled litchi exportation of Vietnam recently. After the implementation, VietGAP litchi has been accepted by several foreign markets such as South Korea, ASEAN, Russia, and especially Japan, as Japanese customers strongly prefer the taste and color of Luc Ngan VietGAP litchi (Ministry of Science and Technology, 2014). Litchi export value increased rapidly from under US\$1 million in 2008 to nearly US\$20 million 2014 as VietGAP production increased (Department of Industry and Trade Bac Giang, 2014; Vietnam Trade Promotion Agency, 2014a).

Although VietGAP litchi in Luc Ngan has gradually acquired significant recognition by many foreign trade partners, the adoption rate was negligible. In 2014, there were 243 out of about 40,000 households holding valid VietGAP certification; whereas many others still follow conventional practices by applying chemical pesticides and fertilizers, or even untreated organic fertilizers. Questions arise as to why the adoption rate is modest. Which GAP criteria prevented farmers' adoption? This study therefore sought to investigate farmers' attitude to different aspects of VietGAP, and explore the main VietGAP criteria that serve as a barrier for farmer adoption of VietGAP. Several studies explored the determinant of GAP or sustainable agricultural practice adoption. Those studies emphasized the influence of farmer characteristics, farm characteristics, or exogenous factors such as national policy on adoption decision (Athipanyakul *et al.*, 2012; D'Souza *et al.*, 1993; Loan *et al.*, 2016; Pongvinyoo *et al.*, 2014; Teklewold *et al.*, 2013; Van Thanh *et al.*, 2015). This study focused on analyzing the influence of VietGAP criteria itself on farmers' adoption decision.

## METHODS

### Choice experiment method

For exploring the determinants of VietGAP criteria itself on farmers' adoption decision, the choice experiment (CE) model was used mainly in this study. The CE model relies on two pillars: Lancaster's characteristic theory and Random utility theory by McFadden. Lancaster's characteristic theory of value says that good is featured by set of characteristics so demand for good is described as demand for specific characteristics instead of the whole good itself (Lancaster 1966). The random utility theory derived by McFadden describes a model of individual choice and represent individual's preference by observed part and random part (McFadden 1973).

An individual  $i$ 's random utility  $U$  for alternative  $j$  is assumed to be:  $U_{ij} = V_{ij} + \varepsilon_{ij}$  (1)

Where  $U_{ij}$  is person  $i$ 's utility of choosing alternative  $j$ ;  $V_{ij}$  is the deterministic component of utility which is observable by researchers;  $\varepsilon_{ij}$  is unobserved element or error terms.

Let  $J$  is the set of all possible options. If an individual chooses option  $j$  it means that choice  $j$  is the most preferred option in the choice set  $J$ . The choice made of option  $j$  is modeled as the probability that  $j$  is chosen  $P_i(j/J)$  :

$$\begin{aligned} P_i(j/J) &= \text{Prob} \{ U_{ij} > U_{il} ; \forall j \neq l, l \in J \} \\ P_i(j/J) &= \text{Prob} \{ V_{ij} + \varepsilon_{ij} > V_{il} + \varepsilon_{il} ; \forall j \neq l, l \in J \} \\ P_i(j/J) &= \text{Prob} \{ V_{ij} - V_{il} > \varepsilon_{il} - \varepsilon_{ij} ; \forall j \neq l, l \in J \} \end{aligned} \quad (2)$$

In other words, rational people always choose the option with highest attained utility. From expression (1), assuming that error terms  $\varepsilon_{ij}$  are independently and identically distributed (IID) with an extreme value distribution, the probability of choosing alternative  $j$  in expression (2) was estimated as:

$$P_i(j|J) = \frac{e^{V_{ij}}}{\sum_{l=1}^J e^{V_{il}}} \tag{3}$$

Assuming that individual preferences are heterogenous; the deterministic component of utility can be expressed as vector  $\beta$  random parameter varying among individual, and  $Z_{ij}$  is vector of attribute:  $V_{ij}=\beta Z_{ij}$

Then the probability that individual  $i$  will choose alternative  $j$  is therefore

$$P_i(j|J) = \int \frac{e^{\beta Z_{ij}}}{\sum_{l=1}^J e^{\beta Z_{il}}} f(\beta) d\beta \tag{4}$$

The specification (4) is the mixed logit choice probability, where  $f(\beta)$  is density function specifying distribution of  $\beta$ .

In this study, a litchi farmer's random utility can be written as:  $U_{ij} = V_{ij} + \varepsilon_{ij}$

Generally  $V_{ij}$  is assumed to be linear function of vector of farming practices  $Z$  and vector of coefficient  $\beta$  so a litchi farmer's utility function becomes:

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \sum_{k=1}^K \beta_k Z_{jk} + \gamma P_j + \varepsilon_{ij}$$

Where  $Z_{jk}$  represents growing practice  $k$  of alternative  $j$ ; coefficient  $\beta_k$  is the coefficient associated with practice  $k$ ;  $\gamma$  is marginal utility of money;  $P_j$  is price premium to follow practices in alternative  $j$ .

For simplicity, the subscript  $i$  and  $j$  which represented individual  $i$  and alternative  $j$  are removed.

Our objective turns to estimate the vector of coefficient  $\beta$  and  $\gamma$

$$V = \beta_1 Z_1 + \beta_2 Z_2 + \beta_3 Z_3 + \dots + \beta_K Z_K + \gamma P \tag{5}$$

When farmers have to follow a practice, they need an amount of money to trade off the cost and difficulties incurred. The value that farmers attach to a practice is the implicit price or marginal willingness to accept (WTA) for a change in a single attribute level as specified below.

$$\text{Implicit price for practice } Z_k = -1(\beta_k/\gamma) \tag{6}$$

**Selection of study site**

Litchi is planted mainly in 18 communes (out of a total of 30 communes) in Luc Ngan district and VietGAP procedure has been introduced in 5 litchi growing communes including Hong Giang, Quy Son, Thanh Hai, Phuong Son, and Tan Quang since 2009. However, there are many litchi farm households that have not adopted VietGAP in these 5 communes. Farm management involves

the use of synthetic chemical inputs such as pesticides and fertilizers. Therefore, six communes including 5 VietGAP adoption communes above and one non-VietGAP commune (Giap Son commune) were drawn as the representative study site.

### **Data collection**

Secondary data on litchi production including the litchi area, yield and produce as well as number of litchi households in Luc Ngan district and selected communes were gathered from statistical yearbooks of the district and from related studies. The information on VietGAP introduction and adoption in the district were collected from the report of Department of Agriculture and Rural Development (DARD) at the district level and also from the annual reports on agricultural production in each selected commune.

Household survey: a total of 300 households were selected for direct interviews including 45 VietGAP adopted households, and 255 non-adopted households. The number of litchi farm households in each commune was proportionally taken from selected communes, survey households were randomly selected with regards to VietGAP adoption and non-VietGAP adoption aspect based on the household list provided by Commune Farmer Association. The details of selected households in each communes is presented in Table 1.

**Table 1.** The number of survey households in study sites.

<b>Sample Communes</b>	<b>No. of litchi households</b>	<b>No. of survey households</b>	<b>No. of adopting households</b>	<b>No. of Non-adopting households</b>	<b>Year VietGAP introduced</b>
Quy Son	4,267	76	9	4,258	2009
Hong Giang	2,160	38	120	2,040	2009
Thanh Hai	3,565	63	46	3,519	2013
Tan Quang	2,140	38	28	2,112	2013
Phuong Son	2,789	50	40	2,749	2013
Giap Son	1,960	35	-	1,960	-
<b>Total</b>	<b>16,881</b>	<b>300</b>	<b>243</b>	<b>16,638</b>	

**Source:** Statistical Yearbook of Luc Ngan district, 2014; VietGAP (2014)

The direct interviews with the litchi households were conducted during the fall of 2015 using a standard questionnaire. The first part of the questionnaire focused on collecting socioeconomic and farm characteristics of Luc Ngan litchi farmers. The second part was to gather their attitude toward GAP litchi using Likert five-scale question. The third part was choice experiment design to investigate litchi farmers' preference for different attribute of GAP. There are four main steps in designing choice experiment. *Firstly*, the relevant attributes are identified during focus group discussion with litchi farmers and the head of Farmers Association. Five main concerned criteria of litchi growers during farming practices are premium price, pesticide use, intercrop, animal control, and pre-harvest fruit wrapping requirement. For conventional farming, farmers should follow reference dose on pesticide label and the quarantine periods to comply with normal requirement of Maximum Residue Limit (MRL) of Vietnam Ministry of Health. For VietGAP practice, farmers need to comply with Codex MRLs. For GlobalGAP practices, US and EU have their own MRLs regulated by the US Environmental Protection Agency and EU Food Safety Authority. According to US-EU standard, the pre-harvest interval is normally longer and the maximum application rate is lesser than Codex Alimentarius. These criteria are rationally considered by litchi farmers; therefore they are selected as attributes in choice experiment design of study. *Secondly*, all levels associated with

different attributes are identified as shown in Table 2. *Thirdly*, all levels associated with GAP characteristics were combined and  $3 \times 2 \times 2 \times 2 \times 4 = 96$  combinations of attribute levels were obtained. After that, orthogonal fractional factorial design was used to obtain 16 manageable possible profiles. *Finally*, these profiles were then paired in 8 cards, status quo was included in each card and provided to each respondent with clear explanation. By selecting one among three choices, farmers would reveal their preference.

**Table 2.** Assigned attributes and levels

<b>Attributes</b>	<b>Assigned levels</b>
Pesticide use	1. Normal requirement of MRL (Status quo) 2. Follow Codex MRL (VietGAP) 3. Follow US, EU standard MRL (Global GAP)
Monocropping Cultivation	1. Permit intercropping (Status quo) 2. Prohibit intercropping (VietGAP and Global GAP)
Animal raising	1. Permit animal raising (Status quo) 2. Prohibit animal raising (VietGAP and Global GAP)
Wrapping requirement	1. Leave litchi fruit unwrapped (Status quo and VietGAP) 2. Wrap litchi fruit with special nylon bag (Global GAP)
Price premium	1. 0% 2. 30% higher than average market price 3. 50% higher than average market price 4. 100% higher than average market price

**Analysis procedure**

The empirical analyses of this study relied on three main procedures. Firstly, descriptive statistics method was used to describe the litchi production situation in the districts. Next, comparative analyses was used to identify the differences between the farm groups. Choice experiment model was employed to identify the determinants of GAP criteria on farmers' adoption. Data collected from the choice experiments was the input for mixed logit regression to provide estimated indirect utility function of Luc Ngan litchi growers as in expression (7) which is derived from expression (5) above. After that, Stata software was used to give Delta analysis and statistical analysis (Stata, 1999). The variables in expression (7) is explained in Table 3.

$$V_{ij} = \beta_1 pu_1 + \beta_2 pu_2 + \beta_3 cul + \beta_4 ar + \beta_5 ph + \gamma pp \tag{7}$$

**Table 3.** Variables and description

<b>Variables</b>	<b>Denote</b>	<b>Description</b>
Pesticide use	$pu_1$	1 = Pesticide use under Codex MRL standard; 0=other
	$pu_2$	1 = Pesticide use under US/EU MRL standard; 0=other
Monocroppingcultivation	$cul$	1 = Monocropping litchi; 0 = Intercropping
Animal raising	$ar$	1 = Prohibition of animal raising in litchi orchard 0 = Raising animals in litchi orchard
Wrapping requirement	$wr$	1 = Wrap litchi fruits with nylon bag before harvest 0 = Leave fruits unwrapped before harvest
Price premium	$pp$	Percentage higher than average price

## RESULTS AND DISCUSSION

### Overviews of litchi production in Luc Ngan district

Litchi production in Luc Ngan district started in the 1960s and increasingly expanded during the 1990s. The well-suited natural weather conditions in Luc Ngan district influenced greatly litchi special taste and appearance so that Luc Ngan litchi was certified as the protected trademark by the National Office of Intellectual Property of Vietnam, and received protection certification in Japan, the Republic of Korea, Cambodia, Laos, and China (Department of Industry and Trade Bac Giang 2012). To date, the production area is about 18,000 ha, and production fluctuates between 60,000 and 130,000 tons depending on weather conditions. In 2014, litchi production in Luc Ngan district reached to 130,000 tons due mainly to favorable weather (Table 4).

**Table 4.** Litchi growing area and yield of Luc Ngan district 2010-2014.

	2010	2011	2012	2013	2014
Area (ha)	18,000	18,000	18,000	17,000	18,000
Production (ton)	60,000	90,000	80,000	72,000	130,000

Source: Department of Industry and Trade Bac Giang (2014)

In 2014, Luc Ngan was by far the largest litchi growing region of Vietnam. Its litchi production area was approximated 28% of country's production area, which contributed nearly 35% of the whole country production, as shown in Table 5.

**Table 5.** Litchi production area and yield, 2014.

	Yield (thousand ton)	%	Area (thousand ha)	%
Luc Ngan District	130	35.43	18	28.40
Others	236.89	64.57	45.39	71.60
<b>Whole Vietnam</b>	<b>366.89</b>	<b>100.00</b>	<b>63.39</b>	<b>100.00</b>

Source: Department of Industry and Trade Bac Giang (2014)

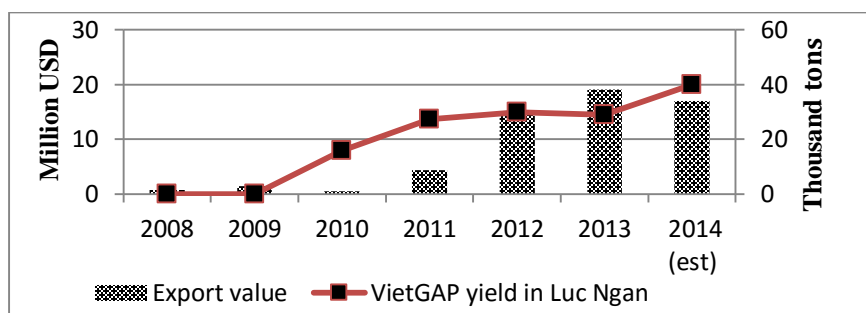
### VietGAP litchi production in Luc Ngan district and farmers' adoption

VietGAP was developed based on GlobalGAP with a lower criteria to harmonize with national conditions. VietGAP provides guidelines for the application of production methods covering food safety, environmental management, worker health, safety, and product quality. There are 12 sections in the standard namely: (1) Site assessment and selection; (2) Planting material; (3) Soil and substrate management; (4) Fertilizers and soil additives; (5) Water and irrigation; (6) Crop protection and use of chemicals; (7) Harvesting and handling; (8) Waste management and treatment; (9) Worker health and welfare; (10) Record keeping, recall, and traceability; (11) Internal audit; and (12) Complaints and resolve complaints. Farmers are subject to mandatory training and guideline production practices to receive VietGAP certification which is valid for two years (Ministry of Agriculture and Rural Development 2008)

The VietGAP pilot project was introduced to local farmers in Quy Son commune in 2008 under the financial support and technical guidance of Canadian International Development Agency. The overall objectives of this program were to enhance responsibility of litchi growers in production, improve the quality safety and marketability of litchi, and enhance economic efficiency for litchi farmers. Accordingly, litchi farmers were provided free training courses, free production site

assessment, and free product inspection. After the success of first production model, VietGAP was implemented in Hong Giang and Quy Son commune. In 2013, Phuong Son, Thanh Hai, and Tan Quang embarked on the expansion. In 2014, there were 12 production groups in five communes having valid certification of VietGAP on the area of 132 ha (VietGAP 2014)

As the result, VietGAP litchi programing Luc Ngan district has achieved remarkable success by enhancing the litchi exportation of Vietnam. As in Fig. 1, from 2008 to 2009, VietGAP project was at starting point and litchi export value stood at around US\$1 million. In 2010, VietGAP production of Luc Ngan was 16 thousand tons; however litchi export value was still negligible since VietGAP litchi was not recognized by foreign customers. From then on, litchi export value increased rapidly as VietGAP litchi has gained increasing acceptance by foreign markets. For instance, litchi export value was US\$15 million in 2012, which was up around 200% compared to that of 2011 (Fig. 1).



**Fig. 1.** Vietnam litchi export value and yield in Luc Ngan 2008-2014.

**Source:** Department of Industry and Trade Bac Giang, 2014; Vietnam Trade Promotion Agency, 2014a

### Sample description

Our sample included 45 adopted households with valid VietGAP certification; and 255 non-adopted households. The sample description is indicated in Table 6.

**Table 6.** Socio-economic characteristics of litchi farmers in Luc Ngan.

*(Average for one survey household)*

Characteristics	Unit					Total (n=300)
		Adopter group (n=45)		Non-adopter group (n=255)		
		Mean	Std. Dev.	Mean	Std. Dev.	
1. Farmer's characteristics						
a. Household size	people	5.09	0.9250	4.96	1.0379	4.98
b. Age	year	46.16	8.7255	43.28	10.1134	43.71
c. Education	year	8.27	3.3737	7.56	2.7743	7.66
2. Farm characteristics						
a. Agricultural land	ha	0.62	0.1749	0.60	0.3698	0.60
b. Litchi land	ha	0.53	0.1629	0.48	0.3391	0.48
c. Annual income	mil. VND	129.67	57.6340	108.58	57.1752	111.74
d. Litchi income	mil. VND	111.80	37.2703	75.02	50.2004	80.54

**Source:** Household survey 2015

Among the 300 household respondents, there are 256 male and 44 female household heads. Two thirds are over 40 years old and the average household size is around 5 persons. The average

agricultural land is 0.60 ha per household, of which litchi production occupies about 0.48 ha, on the average. Litchi production appeared to be the major crop and major income source of our sample households. On the average, litchi orchards make up 80% of the agricultural land of sample families. The mean litchi income is 80.54 million VND (US\$3,661)<sup>1</sup> per year, which accounts for 72% of total household income. Additional sources of income are from salary and other activities like trading or transportation service. Income from livestock is negligible because raising is mainly for family consumption purposes.

### **Farmers' attitude toward GAP**

Table 7 presents the proportion of farmers who attended the training course about VietGAP and GlobalGAP for litchi with respect to group of farmers. It can be seen that farmers know more about VietGAP than GlobalGAP. About 67% of total respondents stated that they know about VietGAP. Specifically, VietGAP comprises a set of practice regulated by government to produce clean and safe litchi. There was 40% of respondents attending VietGAP training courses by local authority. Of two groups, all the adopters attended official VietGAP training program; whereas, only 29% of non-adopters joined the training class.

Besides, 30% of total respondents knew about GlobalGAP litchi, and small proportion (7%) was provided official training about GlobalGAP. Of two groups, VietGAP farmers seemed more interested in GlobalGAP litchi since 42% of this group attended GlobalGAP litchi class; whereas most of non-VietGAP farmers (99.22%) ignored GlobalGAP litchi training programs.

**Table 7.** Distribution of respondents with knowledge and attendance in training course about GAP.

		<b>% of total adopters (N=45)</b>	<b>% of total non- adopters (N=255)</b>	<b>% of total farmers (N=300)</b>
1. Knowledge about VietGAP litchi	yes	100	61.2	67
	no	0	38.8	33
2. Attended VietGAP litchi training	yes	100	29.4	40
	no	0	70.6	60
3. Knowledge about GlobalGAP litchi	yes	84.4	20.4	30
	no	15.6	79.6	70
4. Attended GlobalGAP litchi training	yes	42.2	0.8	7
	no	57.8	99.2	93

Source: Household survey 2015

A majority of litchi producer participants expressed positive attitude toward different aspects of VietGAP litchi production. About 95% of respondents asserted that VietGAP helps to reduce pollution, farmers' exposure to health hazards, and pest infestation (Table 8). According to the advice of the Agricultural Extension Board, GAP households in the same area should spray pesticides for litchi together at the recommended time. Some adopters said that the frequency of spraying is reduced in half compared to conventional practice since pests were effectively managed after the first spraying. As a result, adverse effects of pesticide are cut down. All of the adopters affirmed that farmers were less exposed to hazard from pesticide use while following VietGAP litchi practices. Most non-adopters (94.1%) also supported this statement.

<sup>1</sup> 1USD=22,000VND



In addition, high proportion of respondents (88.7%) perceived that VietGAP for litchi is sustainable practice for the future. Farmers added that, so far the trade of litchi has been dependent upon the biggest Chinese importer but now they feel very vulnerable due to the political issue between two countries. A small proportion of non-adopters showed disagreement against statement; however, majority of people had a full agreement. This implies that VietGAP practice is promising for majority litchi growers to shift into more stable markets. In addition, 76% of interviewees decisively indicated that VietGAP would offers nice appearance and better quality litchi compared to conventional practices, and also admitted the necessary and important role of recording practice. However a significant number of non-adopter householders expressed hesitation and disagreement against statement.

Finally, 42.4% of interviewees agreed that VietGAP litchi practice would help to reduce input cost of production. Some VietGAP respondents noted that although pesticide prices are more expensive, pesticide expenditure was reduced by about ten percent compared to conventional practice since the frequency of spraying is reduced; other costs appeared to remain the same. However, a large proportion of sample (85.4%) showed uncertainty and disagreement about VietGAP practice being able to increase income. Farmers specified their fundamental concerns on no contract farming while current output price of VietGAP litchi was not enough to compensate for their practice; this registered a neutral and negative attitude. Although farmers showed especially positive attitude toward GAP, there was hesitance to adopt due to the feeling of uncertainty

**Table 8.** Percentage of farmers' attitude toward GAP for litchi.

Statement	Percentage (N=300)				
	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
1. VietGAP litchi is sustainable practice for future	46.3	42.3	9.1	2.3	0.0
2. VietGAP litchi has nicer appearance and better quality compared to conventional litchi	28.0	48.0	18.0	6.0	0.0
3. VietGAP practice is time-consuming	53.0	37.3	4.7	5.0	0.0
4. Recording practice is necessary & important	20.7	49.3	21.3	8.7	0.0
5. VietGAP litchi reduces all forms of pollution	47.0	47.0	6.0	0.0	0.0
6. VietGAP litchi reduces input cost of production	2.7	39.7	49.7	5.7	2.2
7. VietGAP litchi increases farmers' income	1.3	13.3	60.7	22.0	2.7
8. VietGAP litchi reduces farmers' exposure to health hazards	49.0	46.0	2.3	2.7	0.0
9. VietGAP litchi is efficient in reducing pest & disease infestation	45.0	49.7	4.7	0.6	0.0

*Source: Household survey 2015*

**The influence of main GAP criteria on GAP adoption likelihood**

The empirical results of mixed logit model (Table 9) indicates that cultivation, pre-harvest fruit wrapping requirement, pesticide standard, and price premium significantly impact on farmers' adoption decision.

Firstly, monocropping cultivation is negatively related to the growers' utility as expected. It clearly demonstrates that prohibition of intercrop non-litchi fruit in litchi orchard will reduce the utility of litchi farmers. Similarly, pre-harvest fruit wrapping requirement has a negative coefficient which implies that the requirement of covering fruit by nylon bag 21 days before harvesting would reduce farmer' utility. Additionally, price premium is found to be strongly positive desirably.

Another specific result of the model is pesticide use variables. Pesticide use following Codex standard and following US or EU standard are both positive and statistically significant at 1% level. In this context, farmer's utility would increase if pesticide use followed international standard. Actually the usage of high standard pesticide is not the main difficulty for litchi growers since they are aware that it would help to lower their health risk. This also agrees with the findings of Tran Huynh Bao Chau et al. (2015) that VietGAP program reduced health problems caused by pesticide exposure.

Finally, the study revealed that animal raising is statistically insignificant factor. In fact the existence of animal raising is not the constraint of VietGAP adoption. Although two thirds of sample households have raised animals, the range is limited; hence animals can be easily be moved elsewhere away from VietGAP practice area.

**Table 9.** Estimated coefficients of mixed logit model for GAP litchi preference

Variables	Estimated Coefficients	
	Coeff.	Std. Err
Mean		
Monocropping cultivation	-0.43886***	0.1510903
Wrapping requirement	-1.65971***	0.1722495
Animal raising	0.03568	0.1276922
Price premium	0.27206***	0.0314727
Pesticide use_US	0.55126***	0.1591618
Pesticide use_Codex	0.62467***	0.1897499
SD		
Monocroppingcultivation	1.19085***	0.2094027
Wrapping requirement	1.75394***	0.2069804
Animal raising	0.04108	0.5770746
Price premium	0.11461***	0.0395126
Pesticide use_US	0.04688	0.2857956
Pesticide use_Codex	0.35449	0.5635703
Number of observation	3600	
Log likelihood	-1087.607	
Chi <sup>2</sup>	100.43	

Note: <sup>1</sup>/\*, \*\*, \*\*\* denote significance at 10%, 5% and 1% levels, respectively

<sup>2</sup>Mixed logit model was used because it extends conditional logit model by allowing the parameters in the model to be randomly distributed such as *culphpp*

We estimate the implicit price for each GAP practice as in Table 10. Litchi farmers would require price premium of 6,100 VND per kilogram higher than conventional litchi price (10,000VND per kilogram) for wrapping fruit using nylon bag at 21 days before harvest. This is a challenging task for farmers since it is laborious to bag each bunch of fruit. Besides, a price premium of 1,613 VND

per kilogram compared to price of conventional litchi would be enough for farmers to switch from intercropping to monocropping.

Pesticide variables are not the barriers of GAP adoption since our litchi farmers prefer the application of pesticide under Codex criteria (VietGAP) and EU/US criteria (GlobalGAP). It is important to highlight that litchi farmers truly illustrate positive attitude toward pesticide under Codex standard (VietGAP) or US/EU standard (GlobalGAP) because most of the respondents agree that “VietGAP litchi practice reduces farmers' exposure to health hazards”. Non-GAP farms should practice according to the advice of Extension Board, which means they have a choice whether to follow or not. However, GAP-farms have to follow the advice of Extension Board. For example, Extension Board informs the spraying schedule, adopted farmers have to spray according to schedule. If they are busy, they have to hire labor to do that. In case of non-GAP farms, if they are busy, they normally delay the spraying schedule. Moreover, several adopter households admitted that “the frequency of spraying is reduced by half compared to conventional practice”, or “application of pesticides according to VietGAP litchi, pesticide cost is reduced by about ten percent since the frequency of spraying is reduced”. Obviously, it would be much more efficient when all households in the same neighborhood spray pesticides at the same time. Moreover, farmers are aware that the use of high standard pesticide in accordance with VietGAP requirement would be much safer for pesticide applicators, hence the farmers do not ask for price premium for pesticide use requirement and implicit price is negative (Table 10).

**Table 10.** Estimated implicit price to follow single practice

<b>Attribute</b>	<b>Variables Denote</b>	<b>Implicit price (VND)</b>	<b>P_value</b>	<b>95% Confidence Interval</b>	
Wrapping requirement	<i>wr</i>	6,100	0.000	-7.55580	-4.64496
Monocropping cultivation	<i>cul</i>	1,613	0.001	-2.59320	-0.63289
Pesticide use_US	<i>pu_us</i>	-2,026	0.004	0.64714	3.40528
Pesticide use_Codex	<i>pu_codex</i>	-2,296	0.001	0.88665	3.70543

Note: The significant level was tested by Delta method.

## CONCLUSION

Luc Ngan district has been best known as predominantly a litchi production region of Vietnam and VietGAP has been introduced to litchi farm households in the district since 2008 in order to meet food safety standards for exportation. However, the adoption rate for VietGAP in the district is still low. The study results show that majority of litchi farmers expressed positive attitude toward different aspects of VietGAP litchi production. The study also focused on analyzing 5 VietGAP criteria that affect the adoption decision of litchi farmers in the district and reveal that wrapping requirement, monocrop cultivation, and price premium are significant factors for farmers' choice of adoption. Farmers require price premium of 6,100 VND per kilogram (equivalent to 60% of current price of conventional litchi) to comply with pre-harvest wrapping requirement, and price premium 1,613 VND per kilogram (equivalent to 16% of current price of conventional litchi) to monocrop litchi.

This is the first study investigating the impact of GAP criteria on the likelihood of adoption using choice experiments; hence the findings would fill in the literature gap about application of CE in studying GAP adoption determinants. Moreover, this study would be the useful reference for policy makers to design effective policies for improving the application of GAP litchi in Luc Ngan district. Local authority should attempt to provide litchi farmers more extension service, training courses, and technical assistance, especially for wrapping fruits, to tackle the biggest challenge of farmers against

GlobalGAP adoption. The study also revealed that if farms in same neighboring area are organized as production group and spray pesticides simultaneously per advice of Extension Board, the cost of pesticide and frequency of spraying will be reduced considerably. In fact, MARD only assigns VietGAP certification for production groups instead of individual households. Many farms do not adopt VietGAP due to non-adoption of VietGAP by their neighborhood. Therefore, organizing litchi farmers as production groups would help to address problems of spraying pesticides and form the necessary base for VietGAP compliance.

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### **REFERENCES**

- Athipanyakul, T. and W. Pak-Uthai. 2012. Determinants of good agricultural practices (GAP) adoption in the chili production system in Northeastern Thailand: A case of participatory approach. *International Journal of Environmental and Rural Development*. 3(2):175-180.
- Commonwealth Secretariat. 2001. Guidelines for exporters of fruit and vegetables to the European markets. 206 p.
- D'Souza, G., Cyphers, D., and T. Phipps. 1993. Factors affecting the adoption of sustainable agricultural practices. *Agricultural and Resource Economics Review*. 22(2):159-165.
- Department of Industry and Trade Bac Giang. 2012. Report on litchi production of Bac Giang province in 2012. Vietnam. 6 p
- Department of Industry and Trade Bac Giang. 2014. Report on litchi production of Bac Giang province in 2014. Vietnam. 13 p
- Evans, E. A., and R. L. Degner. 2005. Recent developments in world production and trade of lychee (*Litchi chinensis*): Implications for Florida growers. *Proc Fla State Hort Soc*. 118, 247-249
- Food and Agriculture Organization [FAO]. 2002. Lychee production in the Asia-Pacific region. FAO/RAP Publication 2002/04 (Bangkok). 134 p.
- Ghosh, S. 2001. World trade in litchi: past, present and future. Paper presented at the International Symposium on Litchi and Longan. China. 30 August 2001. 558 p.
- Lancaster, K. 1966. A new approach to consumer theory. *Journal of Political Economy*. 74:132-157.
- Loan, L. T. T., I. M. Pabuayon, S. P. Catelo, and Z. M. Sumalde. 2016. Adoption of Good Agricultural Practice (VietGAP) in the lychee industry in Vietnam. *Asian Journal of Agricultural Extension, Economics & Sociology*. 8(2):1-12.
- McFadden, D. 1973. Conditional logit analysis of qualitative choice behavior. *Frontiers in Econometrics*. New York: Academic Press. pp. 105-142.
- Ministry of Agriculture and Rural Development Vietnam. 2008. Decision No. 379/QD-BNN-KHCN Good Agricultural Practices for production of fresh fruit and vegetables in Vietnam. 25 p.

- Ministry of Science and Technology Vietnam. 2014. Vietnam's litchi participating in Tokyo exhibition for agricultural products-Japan. 2 p.
- Pongvinyoo, P., Yamao, M. and K. Hosono. 2014. Factors affecting the implementation of good agricultural practices (GAP) among coffee farmers in Chumphon province, Thailand. *American Journal of Rural Development*. 2(2):34-39.
- Stata. 1999. What is the delta method and how is it used to estimate the standard error of a transformed parameter? Available Source: <http://www.stata.com/support/faqs/statistics/delta-method/>
- Statistical Yearbook of Luc Ngan district. 2014. Statistical Year Book Luc of Ngan district. Luc Ngan, June 2015.85 p.
- Teklewold, H., Kassie, M. and B. Shiferaw. 2013. Adoption of multiple sustainable agricultural practices in rural Ethiopia. *Journal of Agricultural Economics*. 64(3):597-623.
- Tran Huynh Bao Chau and Le Thi Quynh Anh. 2015. Impact of safer pesticide use on the health of farmers- A study from Vietnam (NO.2015-PB12). *Economy and Environment Program for Southeast Asia Publication*. 19 p.
- Van Thanh, N. and C. Yapwattanaphun. 2015. Banana farmers' adoption of sustainable agriculture practices in the Vietnam Uplands: The Case of Quang Tri Province. *Agriculture and Agricultural Science Procedia*. 5: 67-74.
- VietGAP. 2014. VietGAP certified enterprises. Ministry of Agricultural and Rural Development Publication. 5 p.
- Vietnam Trade Promotion Agency. 2014a. Vietnam's lychee export potentials and forecast – Part 1. *Vietname Trade Promotion Agency Publication*. 3 p.
- Vietnam Trade Promotion Agency. 2014b. Vietnam's lychee export potentials and forecast – Part 2. *Vietname Trade Promotion Agency Publication*. 3 p.