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Factors affecting farmers' adoption of good agricultural practice in vegetable production in the upper North of Thailand

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Abstract Results revealed that ten factors contributed to an increase in the probability that farmers adopted high-level GAP principles and a decrease in the probability that farmers adopt low-or moderate-level GAP principles. These factors include owning capital for GAP vegetable production, borrowing capital for GAP vegetable production, diversity of GAP vegetables, suitable prices, the knowledge provided by private entities on the food safety of GAP vegetables, a positive attitude toward GAP vegetable production, being a member of Bank for Agriculture and Agricultural Cooperatives, being a member of a farmer group, being a member of a community enterprise, and being a member of other interest groups. Meanwhile, the six factors associated with a decreased likelihood that farmers adopt high-level GAP, and a subsequent increased probability that farmers adopted low-or moderate-level GAP included age, education, freshness of GAP produce, knowledge provided by government agencies on the food safety of GAP vegetables, being a member of a village fund, and satisfaction with participation in training on GAP standards.

Keywords: Factors affecting adoption, Good Agricultural Practice (GAP), GAP vegetables

Introduction

Thailand has embraced the green revolution for over 50 years to increase agricultural productivity. The technological package of the green revolution includes the use of chemical fertilizers and other agrochemicals. This led to a great rise in the importation of chemical fertilizers and agrochemicals from 2005 - 2017. In particular, the importation of herbicides, pesticides, and fungicides grew at an average rate of 34.75 %, 19.22 %, and 5.44 % per year, respectively; while the importation of chemical fertilizers grew at a rate of 5.58 % per year with a 5.82 million ton import volume in 2017 (Office of Agricultural Economics, 2017). Agricultural chemical inputs are

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used most heavily in vegetable farming, resulting in a high concentration of chemically contaminated crops. In fact, vegetables have been detected more than any other crop to contain chemical residues exceeding allowable standards. This is because vegetable growers tend to apply chemical inputs intensively to shorten cropping time maturity and get a quick return (Kramol *et al*., 2010). From 2013 – 2018, the export values of Thai vegetables in fresh, refrigerated, frozen, dried, and other forms to the world market averaged 8,063.63 million baht per year, with an average annual growth rate of 7.63 % (Ministry of Commerce, 2018). However, allowing Thai produce to be contaminated with chemical residues in order to achieve a longer shelf-life risks losing market opportunities in Thailand's major vegetable export markets, such as the European Union. As a promising importer of fresh vegetables from Thailand, EU markets are an important vegetable market for Thailand. Fresh GAP produce has potential to be exported to EU markets. The produce for which chemical residues were detected to be at the maximum residue limits (MRLs) were holy basil, sweet basil, lemon basil, cumin, sweet pepper, spur pepper, bird chili pepper, Vietnamese eggplant, Italian eggplant, purple eggplant, yellow eggplant, white eggplant, Thai eggplant, Chinese bitter cucumber, Thai bitter cucumber, culantro, yard-long bean, and the cruciferous vegetables. Yet, the export value of fresh vegetables from Thailand to the EU has greatly fluctuated, with an average negative growth rate of 20.01 % per year according to 2008-2018 statistics (Thai Customs Department, 2018). The EU acts as a key establisher of consumers' health protection measures for food safety controls, systems, and legislation to all member countries. Inspection is made to ensure that fresh vegetables in the market contain acceptable amounts of chemical residues from either fertilizer, insecticide, or other chemical substances, and that they are not contaminated with *Salmonella* or *Escherichia coli*. Food hygiene is another inspection concerned even without insect or pest contamination of fruits and vegetables in the market.

Ensuring no problems regarding personal and food hygiene when handling agricultural products is one way to enhance the demand of Thai vegetables in both domestic and export markets. This means all parties involved in the production, processing, and marketing of the products must prioritize food safety, which can be ascertained at the production level if the crops are GAP (Good Agricultural Practices) certified. The implementation of GAP enables consumers to consume safe and wholesome food, earns farmers a worthwhile farming investment and sustainable agriculture, and leaves the natural environment uncontaminated. The GAP standard is a certification system established by the Food and Agriculture Organization of the United Nations (FAO). GAP requires the adherence to various principles when

determining cultivation areas, during crop-care, harvesting, and postharvest activities, and while keeping records of all activities to enable the traceability (National Bureau of Agricultural Commodity and Food Standards, 2019). GAP is a first step for the reduction of the use of agrochemicals in vegetable farming before advancing further to conduct organic farming. Extensive adoption of GAP farming practices is an important mechanism that supports policy action in Thailand that would implement laws regarding food and agricultural standards of health and environmental benefits in order to increase adequate access to safe food.

Consequently, the research aimed to analyze the factors affecting farmers' adoption of GAP in order to determine incentives that can be used to encourage a wider adoption of GAP among farmers.

Materials and methods

Stratified random sampling was used to take samples from the population of farmers who are registered as certified GAP (Good Agricultural Practices) by the Department of Agriculture, and samples were proportionate to the number of farmers in the villages, sub-districts, districts, and provincial levels. The provinces included were Chiang Mai, Chiang Rai, Lamphun, and Lampang, all in the upper North of Thailand, which were grouped together to register GAP farms in 2014. Samples from these provinces included 138, 50, 95 and 100 GAP farming households, respectively. The total was 383 sampled households for investigation using a structured questionnaire containing items in the following categories: general background information, GAP vegetable production and distribution management, socio-economic information, and assistance to the farming households from government and private agencies.

Because the dependent variables of interest factors affecting the adoption of GAP are ordinal categorical variables, the Ordered Probit Model employed by Damisa and Yohanna (2007) was used in this study to analyze the polychotomous response data. This model is more popular than the Ordered Logit counterpart (Maneejuk, 2018) in economic studies since most estimated economic variables have error terms that are normally distributed and the model estimated by the Maximum Likelihood Estimation method is appropriate for the analysis of qualitative data which have an ordinal scale or, in other words, are ordered categories (Asteriou and Hall, 2007). Consider the model of Damisa and Yohanna (2007),

$$Y_i^* = \beta' X_i + \varepsilon_i$$

$$Y_i^* = 0 \text{ if } Y_i^* \le 0 \quad \text{or}$$
$$= 1 \text{ if } 0 < Y_i^* \le \gamma_1$$
$$= 2 \text{ if } Y_i^* > \gamma_1$$

$$\text{prob}(Y = 0) = P(Y_i^* \le 0) = P(\beta' X + \varepsilon_i \le 0) = \phi(-\beta' X)$$

$$\text{prob}(Y = 1) = \phi(\delta_1 - \beta' X) - \phi(-\beta' X)$$

$$\text{prob}(Y = 2) = 1 - \phi(\delta_1 - \beta' X)$$

The obtained coefficient estimate of each independent variable will be transformed into Marginal Effect using the following formula:

$$\frac{\text{dprob}[Y_k]}{dX_k} = \left[\phi(\delta_{k-1} - \beta' X_k) - \phi(\delta_k - \beta' X_k)\right]\beta$$

Let $\text{prob}[Y_k]$ be the probability that Y_k will happen, Y_k be the threshold parameters, and X_k be the k^{th} independent variable. Then the marginal effect will indicate the probabilistic change in the mean score of the level of GAP adoption given a one unit change in the mean value of an independent variable (X_i) or the change of a dummy variable from 0 to 1.

Y_i^* is the unobserved latent variable which will be fixed as an observable dummy variable to reflect the probability of the mean score of GAP adoption. Adoption means compliance with the standard requirements of the National Bureau of Agricultural Commodity and Food Standards and the record-keeping requirements for GAP output quality management of the Department of Agriculture, with a level measured by Likert Scale with the minimum value of 0, and aggregate results interpreted as low, moderate, and high adoption of GAP if the scores are in the range of 0.00-0.66, 0.67-1.33, and 1.34-2.00 respectively.

$\beta_0, ..., \beta_m$ are parameter values.

$X_1, \ldots, X_m$ are independent variables, 37 in total, that can affect vegetable growers' adoption of GAP and are divided into three groups: four personal factors (X_1-X_4), 22 economic factors (X_5-X_{26}), and 11 social factors (X_{27}-X_{37}). The independent variables to be included in the model were determined based on the work of Qiu *et al*. (2017), which used the Human Development Index of UNDP and information about gender, age, education, and GDP per capita to reflect personal factors; the work of Serirat (2003), which used 4P market mix to reflect economic factors; and the study by Amerioun *et al*. (2018), which measured the effectiveness of hospital

employees when responding to service problems in hospitals using the social characteristic of the employees as social factors, which is in line with the population characteristics of buyers of organic products (Panplum, 2016).

Results

An ordered response model was applied to find out the relationship between the three groups of independent variables (personal, economic, and social factors) and the dependent variable in order to determine what factors affect farmers' adoption of GAP principles. Estimation produced a Log-likelihood value = -67.353814, Likelihood Ratio (LR) Chi-square = 193.76, and the Pseudo R-square = 58.99 which indicates the accuracy of the prediction (percentage). This demonstrates that the independent variables do have an influence on the dependent variable. Nine independent variables, X_2, X_3, X_5, X_6, X_{12}, X_{15}, X_{30}, X_{34}, and X_{37}, had a significant effect on the farmers' adoption of GAP principles at P = 0.01. The independent variable, X_{33} was statistically significant at P= 0.05, and the remaining six independent variables, X_{16}, X_{25}, X_{26}, X_{28}, X_{31}, and X_{36}, had a significant effect at P= 0.10. Meanwhile, the estimated marginal effect indicates how the probability of adoption changes with a particular independent variable (Table 1). The effect and marginal effect of each statistically significant variable on the farmers' adoption of GAP principles is interpreted as described below.

The statistically significant independent variables can be divided into 2 groups: those with a negative effect on the probability of adoption of the GAP principles and those with a positive effect as seen in Table 1. The results indicate that the proportion of owned capital (X_5) and borrowed capital (X_6) for GAP production, satisfaction with the diversity (X_{12}) and reasonable prices of GAP vegetables (X_{16}), the awareness of knowledge provided by the private entities regarding the food safety feature of GAP vegetables (X_{26}), attitude toward the production of GAP vegetables (X_{28}), being a member of the Bank for Agriculture and Agricultural Cooperatives (X_{30}), being a member of a farmers' group (X_{31}), being a member of a community enterprise (X_{33}), and being a member of other interest groups (X_{36}) were found to positively influence farmers' compliance with the GAP principles. In terms of the marginal effect values, a change in the independent variables influenced the mean probability score of the level of GAP adoption. It could be concluded that these independent variables will result in an increase of farmers' high-level adoption of GAP, while reducing the likelihood that farmers adopt a low or moderate level of GAP. A unit increase in each the X_5, X_6, X_{12}, X_{16}, X_{26}, X_{28}, X_{30}, X_{31}, X_{33}, and X_{36} led to in the increase of farmers' adoption of high-level GAP by 0.02147 %, 0.02178 %, 0.30048 %, 0.25587 %, 0.13149 %, 0.64279

%, 0.62004 %, 0.20177 %, 0.54174 %, and 0.13060 %, respectively, while decreasing the probability that farmers will adopt a low level of GAP by 1.81e-09 %, 1.84e-09 %, 2.54e-08 %, 2.16e-08 %, 1.11e-08 %, 5.42e-08 %, 1.59e-07 %, 1.63e-08 %, 4.57e-08 %, and 6.04e-09 %, respectively. Further, a unit change in these variables had a negative impact on the probability of farmers adopting moderate-level GAP by 0.02147 %, 0.02178 %, 0.30048 %, 0.25587 %, 0.13149 %, 0.64279 %, 0.62004 %, 0.20177 %, 0.54174 %, and 0.13060 %, respectively.

Table 1. Maximum Likelihood Estimates and Marginal Effects from Ordered Probit Model

Independent variable	Maximum Likelihood Estimates			Marginal Effects		
	Coefficient	S.E.	$P>\|z\|$	Y=1 (Low Acceptance: 0.00-0.66)	Y=2 (Medium Acceptance: 0.67-1.33)	Y=3 (High Acceptance: 1.34-2.00)
Gender (X_1)	-0.5151	0.3581	0.1500	1.73e-10	0.0020443	-0.0020443
Age (X_2)	-0.0837	0.0212	0.0000***	2.80e-11	0.0003323	-0.0003323
Education (X_3)	-0.8195	0.1806	0.0000***	2.74e-10	0.0032526	-0.0032526
Experience growing GAP vegetables (X_4)	0.0228	0.0181	0.2080	-7.62e-12	-0.0000903	0.0000903
Proportion of owned capital for producing GAP vegetables (X_5)	0.0541	0.0202	0.0070***	-1.81e-11	-0.0002147	0.0002147
Proportion of borrowed capital for producing GAP vegetables (X_6)	0.0549	0.0210	0.0090***	-1.84e-11	-0.0002178	0.0002178
Net income from GAP vegetable production (X_7)	0.0000	0.0000	0.7520	2.91e-16	0.0000000	0.0000000
Farmland holding status (X_8)	0.1978	0.2903	0.4960	-6.63e-11	-0.0007851	0.0007851
Satisfaction with food safety from consuming GAP vegetables (X_9)	0.4389	0.2805	0.1180	-1.47e-10	-0.0017419	0.0017419
Satisfaction with information and certification labels on packaging (X_{10})	-0.1728	0.3082	0.5750	5.79e-11	0.0006860	-0.0006860
Satisfaction with the attractiveness of packaging (X_{11})	0.3843	0.2351	0.1020	-1.29e-10	-0.0015254	0.0015254
Satisfaction with the diversity of GAP vegetables (X_{12})	0.7571	0.2637	0.0040***	-2.54e-10	-0.0030048	0.0030048

Table 1. (continued)

Independent variable	Maximum Likelihood Estimates			Marginal Effects		
	Coefficient	S.E.	$P>\|z\|$	Y=1 (Low Acceptance: 0.00-0.66)	Y=2 (Medium Acceptance: 0.67-1.33)	Y=3 (High Acceptance: 1.34-2.00)
Satisfaction with the adequacy of GAP vegetable output volume (X_{13})	0.0989	0.3008	0.7420	-3.31e-11	-0.0003925	0.0003925
Satisfaction with the uniformity of GAP vegetable production (X_{14})	-0.0419	0.1911	0.8260	1.40e-11	0.0001663	-0.0001663
Satisfaction with the freshness of the GAP vegetables (X_{15})	-0.9917	0.2996	0.0010***	3.32e-10	0.0039362	-0.0039362
Satisfaction with the reasonable prices of the GAP vegetables (X_{16})	0.6447	0.3616	0.0750*	-2.16e-10	-0.0025587	0.0025587
Satisfaction with the reasonable prices for the quality of the GAP vegetables (X_{17})	-0.2444	0.3863	0.5270	8.18e-11	0.0009699	-0.0009699
Satisfaction with the diversity of places selling the GAP vegetables (X_{18})	-0.1390	0.3459	0.6880	4.66e-11	0.0005518	-0.0005518
Satisfaction with the GAP vegetable selling places displaying a conspicuous sign of GAP produce (X_{19})	-0.0266	0.2818	0.9250	8.89e-12	0.0001054	-0.0001054
Satisfaction with the constant advertisement regarding the selling places (X_{20})	0.3602	0.2534	0.1550	-1.21e-10	-0.0014295	0.0014295
Satisfaction with the cleanness and convenience of the selling places (X_{21})	0.2989	0.2948	0.3110	-1.00e-10	-0.0011865	0.0011865
Satisfaction with the adequacy of the selling places (X_{22})	-0.1062	0.2729	0.6970	3.56e-11	0.0004216	-0.0004216
Satisfaction with such GAP vegetable marketing campaign as discount, exchange, give-away and buy one – get something free (X_{23})	-0.0887	0.1919	0.6440	2.97e-11	0.0003522	-0.0003522

Table 1. (continued)

Independent variable	Maximum Likelihood Estimates			Marginal Effects		
	Coefficient	S.E.	$P>\|z\|$	Y=1 (Low Acceptance: 0.00-0.66)	Y=2 (Medium Acceptance: 0.67-1.33)	Y=3 (High Acceptance: 1.34-2.00)
Satisfaction with the travel distance to the selling places (X_{24})	0.1331	0.2273	0.5580	-4.46e-11	-0.0005282	0.0005282
Satisfaction with the knowledge provided by the government agencies on food safety property of the GAP vegetables (X_{25})	-0.3840	0.2265	0.0900*	1.29e-10	0.0015243	-0.0015243
Satisfaction with the knowledge provided by the private entities on food safety property of the GAP vegetables (X_{26})	0.3313	0.1854	0.0740*	-1.11e-10	-0.0013149	0.0013149
Level of the GAP vegetable production knowledge (X_{27})	0.0242	0.0196	0.2180	-8.09e-12	-0.0000959	0.0000959
Attitude toward the GAP vegetable production (X_{28})	1.6195	0.8650	0.0610*	-5.42e-10	-0.0064279	0.0064279
Member of agricultural cooperative (X_{29})	0.6429	0.4209	0.1270	-2.15e-10	-0.0025516	0.0025516
Member of the Bank for Agriculture and Agricultural Cooperatives (X_{30})	1.1747	0.4180	0.0050***	-1.59e-09	-0.0062004	0.0062004
Member of farmers group (X_{31})	0.8061	0.4419	0.0680*	-1.63e-10	-0.0020177	0.0020177
Member of Farmers Rehabilitation and Development Fund (X_{32})	1.1563	0.8521	0.1750	-1.14e-10	-0.0017710	0.0017710
Member of community enterprise (X_{33})	1.3649	0.6051	0.0240**	-4.57e-10	-0.0054174	0.0054174
Member of village fund (X_{34})	-1.1899	0.3808	0.0020***	1.42e-08	0.0164310	-0.0164310
Member of kinship group (X_{35})	0.3360	0.4860	0.4890	-1.13e-10	-0.0013338	0.0013338
Member of other interest groups (X_{36})	1.7641	0.9404	0.0610*	-6.04e-11	-0.0013060	0.0013060
Level of satisfaction with the participation in training on the GAP standards (X_{37})	-0.5652	0.2038	0.0060***	1.89e-10	0.0022435	-0.0022435

Note: ***, **, * A significant level of 0.01, 0.05, and 0.10, respectively

On the other hand, age (X_2), education level (X_3), satisfaction with the freshness of GAP vegetables (X_{15}), awareness of knowledge provided by

relevant government agencies on the food safety aspect of GAP vegetables (X_{25}), being a member of a village fund (X_{34}), and satisfaction with the participation in training on GAP standards (X_{37}) had an inverse relationship with compliance with GAP principles. Regarding the marginal effect, the results indicated that these independent variables can explain a decrease in farmers' high level of adoption of GAP standards, while increasing the likelihood that farmers adopt GAP at a low or moderate level. A unit change in X_2, X_3, X_{15}, X_{25}, X_{34}, and X_{37} led to decrease of farmers' adoption of high-level GAP by 0.03323 %, 0.32526 %, 0.39362 %, 0.15243 %, 1.643109 %, and 0.22435 %, respectively, while increasing the probability that farmers adopt a low level of GAP by 2.8e-09 %, 2.74e-08 %, 3.32e-08 %, 1.29e-08 %, 1.42e-06 %, and 1.89e-08 %, respectively. Further, a unit change in these independent variables increased the probability that farmers would adopt a moderate level of GAP by 0.03323 %, 0.32526 %, 0.39362 %, 0.15243 %, 1.64310 %, and 0.22435 %, respectively.

Discussion

This research on the factors affecting farming households' adoption of GAP in vegetable production in Northern Thailand employed the latent variable approach of the ordered probit model (Office of Agricultural Economics, 2018). The ordered probit model is used more frequently than the ordered logit alternative in economic analysis (Maneejuk, 2018) because most economic variables have normally distributed errors and can be estimated by the maximum likelihood procedure. This is suitable for analyzing qualitative variables measured on an ordinal scale involving only ranking or ordering of the data (Asteriou and Hall, 2007). This study divided the adoption of GAP into three levels: low, moderate, and high. Furthermore, it calculated the marginal effect of each level of adoption to explain how the predicted probability of adoption will change with a one-unit change in each independent variable from its mean value or with the change of a dummy variable. If the estimated coefficient of the independent variable has a positive sign, this indicates that a change in the independent variable will increase the chance of adoption of high-level GAP. A negative sign indicates the opposite effect.

The independent variables having positive statistically significant coefficients, indicating an increased probability that farmers will adopt high-level GAP were found to be X_5, X_6, X_{12}, X_{16}, X_{26}, X_{28}, X_{30}, X_{31}, X_{33}, and X_{36}. They can be divided into four main categories: group/organization membership (X_{30}, X_{31}, X_{33}, and X_{36}), capital for GAP vegetable production (X_5 and X_6), diversity and reasonable prices of GAP vegetables (X_{12} and X_{16}), and

knowledge received from private firms on food safety of GAP vegetables and attitude toward GAP vegetable production factors (X_{26} and X_{28}). Therefore, government agencies and private firms wishing to see a greater extent of GAP vegetable production should prioritize providing support for farmers so they will have more capital for producing GAP vegetables, which will result in greater crop diversity and more reasonable prices for both producers and consumers. These observations are consistent with the study of Al-Amin *et al*. (2020), which found that the financial capacity of farmers had a bearing on their willingness-to-accept and -pay for the planned climate change adaptation and that the private sector should play an important role in providing food safety knowledge to farmers, encouraging farmers to be members of the BAAC, farmers' groups, community enterprises, and other interest groups. Working as a group can lead to greater bargaining power, marketing opportunities, and market competitiveness. Group organization in the form of a cooperative is an important factor that leads to farmers' greater willingness to adopt environmentally friendly production (Li *et al*., 2020). Meanwhile, the adoption of smart farms depended on technology compatibility, financial costs for the organization, and the digital environment change (Yoon *et al*., 2020). Moreover, Suwanpingkham (2009) indicated that farmers' knowledge about GAP for chemical-safe vegetable production is a factor affecting the actual implementation of GAP for producing chemical-safe vegetables. Similarly, farmers' knowledge about organic agriculture and their attitude toward organic farming have an effect on farmers' adoption of technologies for organic farming (Sunthonphan, 2009). Likewise, the study by Taitaemthong (2011) found that training on Arabic coffee cultivation technology and farmers' attitudes had an association with farmers' adoption of the technology. Thus, there is a need to keep providing knowledge and public relations services to farmers to encourage farmers' to adopt the technologies. Sirilerdwimon (2000) similarly pointed out that knowledge, access to information, and being a member of farmers' groups had an effect on vegetable growers' adoption of insect exclusive net greenhouse technology. It can be seen that the agricultural technology adoption is related to the knowledge farmers have received and farmers' attitude towards the adoption of new technology; particularly, extension activities involving the education and training of farmers to understand the merit of the GAP standards can contribute to the effective, appropriate, and wide implementation of GAP standards for vegetable production (Joshi *et al*., 2019). Furthermore, education and training for vegetable growers resulted in a high level of GAP adoption. The factors related to farmers' knowledge were education, practical experience, training received, contact with extension workers, and access to data and information; while the

factors related to farmers' practice were education, training received, and access to data and information (Mingsakul, 2015). Similarly, a study by Larnlua (2017) indicated that knowledge related to the standard requirements of GAP led to farmers' success in their health food production enterprises.

Determining farmers' attitude is a first important step in understanding their behavior and coping strategies in reducing environmental risk because it is an important factor that influences farmers' decision-making and acceptance of sustainable farming practices (Zeweld *et al*., 2019). Moreover, empirical evidence has demonstrated that environmentally concerned consumers who get more information about the products will be ready to pay more for products produced in line with environmental sustainability principles (Lanfranchi *et al*., 2019).

To ensure an efficient extension program, there is a need to provide continued extension services to build a greater understanding of GAP among farmers, and the GAP Manual should be developed to suit farmers' educational backgrounds. Although the factor of education (X_3) in this study likely leads to a reduction in the probability of adoption of a high level of GAP, successful group cooperation will encourage farmers to be aware of GAP, which in turn will lead to efficient implementation (Pongvinyoo *et al*., 2014). Likewise, a study by the Office of Agricultural Economics (2018) found that farmers' formation into a group, the transfer of technology using an easy-to-understand language, and the frequency of training sessions are factors that influence farmers' readiness to adopt technology and innovation for producing rice with a high level of GAP implementation and implementing GAP to a wider extent. Similarly, Nicetic *et al*. (2010) stated that the use of the participatory approach in applying for GAP certification led to the success of cooperation between government and private sectors in citrus production. Nevertheless, whether or not a household adopts GAP is a function of household labor availability, land ownership, and expectation about the market opportunity of GAP rice (Srisopaporn *et al.*, 2015). Besides, economic feasibility was not found to be a main driver among farmers for acquiring the GAP certificate (Marine *et al*., 2016). Moreover, it is not possible to conclude that the sustainability of GAP certification is a result of economic benefits for GAP-certified farmers compared to those farmers who fail to achieve GAP certification (Nicetic *et al*., 2010). This is reflected by the score of an independent variable - namely farmers' satisfaction with the training on GAP standards (X_{37}) – which varies inversely with the adoption of GAP, and the factor of the freshness of GAP vegetables (X_{15}) which does not guarantee that farmers can sell GAP vegetables at a higher price. Meanwhile, marketing channels had an effect on farmers'

decision to produce GAP vegetables for food safety reasons which brought about the effective GAP implementation (Marine *et al.*, 2016).

However, the intervention has to be made with careful consideration of the variables X_2, X_3, X_5, X_{25}, X_{34}, and X_{37} which are likely to reduce the likelihood of adopting a high level of GAP. The style of the transfer of knowledge from government agencies involving the food safety of GAP vegetables might need to be changed. Instead of using only lectures a demonstration plot for GAP vegetable growing and practices could be set up or simulation-style activities could be designed to clearly show the food safety of GAP vegetables used as main ingredients in cooking. The content of instruction and demonstration should also be up-to-date, concise, and practical for the effective production of GAP vegetables. Furthermore, the members of village funds should consider the strength that comes from groups of people who have a common determination to genuinely make changes for the benefits of the larger society.

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