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AGRICULTURAL AND NATURAL RESOURCES ADAPTATIONS TO CLIMATE CHANGE

Factors Influencing the Adoption of Good Agricultural Practices and Export Decision of Thailand's Vegetable Farmers

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This research identified and investigated the factors influencing the adoption of good agricultural practices (GAP) and the decision making of small-scale asparagus and sweet corn farmers in Thailand to produce for export. In the study, a total of 147 vegetable farming households (66 and 81 asparagus and sweet corn growers, respectively) were randomly selected from areas with intensive vegetable cultivation. The binary logistic regression was used to analyze the information collected from this survey. The results revealed that the income variable is the most influential factor in the GAP adoption by participating vegetable farmers and that the location factor exerts the most influence over the growers' export decision. Also, it is felt that to effectively increase the GAP adoption rate among the Thai vegetable growers, the exporters and relevant government agencies could make GAP certification compulsory.

Keywords: Good Agricultural Practices (GAP); Export decision; Vegetables export; ASEAN; AEC; Thailand

1. Introduction

The Association of Southeast Asian Nations (ASEAN) is a political and economic organization of 10 Southeast Asian countries. Due to the geography and climate, the region has been the key production hub for several significant economic crops, including rice, fruits, vegetables and coffee. The agricultural trade between ASEAN and non-ASEAN countries is firmly established and considerable, whereas intra-ASEAN trade on agricultural products is relatively underdeveloped.

With the full integration of the ASEAN Economic Community (AEC), it is thus of paramount importance that the intra-ASEAN links be strengthened and the trade in key food products between the member states be enhanced. Notwithstanding, one major obstacle to the success of vibrant intra-ASEAN agricultural trade is the imposition of non-tariff barriers (NTB) to protect their respective domestic industries, e.g., the sanitary and phytosanitary (SPS), global good agricultural practices (GAP), corporate social responsibility (CSR) measures.

In Thailand, the issue of food safety and quality has been better received and implemented in the food production and marketing sectors. This follows a series of news reports about contaminated food exports from Thailand; for instance, Thai chilli was banned by European countries due to pesticide contamination (Ariesen, 2011). According to Roitner-Schobesberger et al. (2008), food scares related to high levels of pesticide residues on vegetables and fruits contributed to Thai consumers increasingly demanding safe foods and the subsequent array of initiatives and labels for pesticide-free vegetables. The country has piloted the sustainable agricultural development policy since the early 1990s (Kasem, 2012). Given the 1997 Asian economic crisis and the United Nations Conference on Environment and Development's Agenda 21, the Thai government has increasingly committed to sustainable agricultural development (Amekawa, 2013).

The risks of food safety hazards can be minimized through the adoption of good agricultural practices (GAP). The GAP adoption in Thailand, however, has progressed at an extremely slow pace (Athipanyakul and Pak-Uthai, 2012). According to Krasuaythong (2008), the adoption of new practices is a complex and time-consuming process by which the adopters' knowledge and willingness play a vital role, particularly regarding knowledge-intensive technologies.

This empirical research has identified and investigated the factors influencing the GAP adoption by Thai small-scale vegetable farmers; and the determinants of the farmers' willingness to engage in the exportation. In the analysis, 66 asparagus and 81 sweet corn farming households were randomly selected from the areas with intensive vegetable cultivation, and the descriptive and binary logistic regression analyses were employed.

The research finding aims to help understand important factors influencing adoption of GAP and improve policy outcomes from food safety issue linking Farm to Fork perspective as well as importance of effective land use practices and efficient use of quality water use with little impact on two important common pool resources viz: land and water.

1.1. Thai vegetables relative to other ASEAN members'

Thailand is Southeast Asia's second largest economy with gross domestic product (GDP) of USD 365 billion in year 2014. The country has been playing a leading role in ASEAN's regional economic integration (the AEC) since the inception of the ASEAN Free Trade Agreement (AFTA) in 1992. According to Nancy (2014), the liberalization associated with the AEC integration could provide the country with numerous prospects for the market and production growth.

In 2012, the global export of Thai vegetables was valued at USD 497.82 million, of which a mere USD 58.03 million (11.66%) was to the ASEAN market. Specifically, the agricultural trades between ASEAN countries are minimal, in comparison with similar trade among EU or North American countries, despite the implementation of the ASEAN Free Trade Area (AFTA). According to Petri et al. (2012), the formation of the AEC could produce gains equivalent to those realized under the European Single Market, amounting to 5.3% of the region's income.

According to Pheesphan et al. (2016), trades in vegetable products among ASEAN member countries have been on an upward trend. The authors documented that fresh vegetable exports from Cambodia and Laos increased significantly by positioning their product range as organically produced vegetables and that Thai vegetable exports were mostly preserved/processed vegetables – given the ubiquity of the technology and added economic value. Meanwhile, Brunei and Indonesia were two principal importers of vegetable products in the ASEAN countries with minimal exports because of the less favorable geographical location and unmet domestic demand.

1.2. Non-tariff barriers among ASEAN countries

One key aim of the AEC is the elimination of trade barriers or import tariffs between the bloc member nations. The successful removal would bring about greater trade opportunities, price competitiveness and the development of various sections in the region. Nevertheless, with the opportunity, invariably comes along the intra-competition and protectionism.

To protect their domestic industry, several ASEAN countries have resorted to a variety of non-tariff barriers (NTBs), in light of the ban on the imposition of tariff barriers. Worse still, the use of non-tariff measures has been on an upward trend. Among the measures commonly deployed are the technical barriers to trade (TBT) and sanitary and phytosanitary (SPS) measures, citing the health and safety of their citizens.

For instance, in Indonesia, prohibitions for sensitive products and non-automatic import licensing are predominantly utilized as the quantity control measures; and the SPS-related measures as the technical regulations. In Malaysia, import permits are deployed as the quantity control measure; and the SPS-related measures as the technical regulations. In the Philippines, the technical regulations take the form of testing and inspection while, in Thailand, technical regulations are principally related to quality standards and inspection and testing. Furthermore, Vietnam's quantity control measures take the form of prohibitions for sensitive products (Pasadilla et al., 2013).

Thus, it is of importance that Thai farmers prepare themselves for more trade liberalization by tracking the market information, consumer behavior, production-related information in other countries. Such information is of prominent use to the management of costs, production techniques and product varieties. More importantly, Thai agriculturists should start acquainting themselves with the accreditation standards and traceability system (e.g., GAP) since the non-tariff SPS measures and food safety are being put forward as a pre-condition for the intra-ASEAN agricultural trade.

1.3. Good agricultural practices (GAP) in Thailand

In Thailand, good agricultural practices (GAP) made its first appearance in 1988. Then, in 2004, the Thai government created the Q-GAP standard for food safety certification. In the following year, ThaiGAP was launched by the Thai Chamber of Commerce in collaboration with the National Food Institute of

Thailand and Thailand's Kasetsart University. Especially, ThaiGAP is a standard on production quality management of fruits and vegetables that focuses on food safety and standardized production systems. Furthermore, ThaiGAP is an equivalent of the GlobalGAP standard and consists of two levels: ThaiGAP Level 1 for manufacturers who want to export and ThaiGAP Level 2 for domestic sales. In 2006, the ASEAN GAP standard was initiated for agricultural trades in the region and is currently still under development. (Korpraditskul, 2010).

GAP is a guideline for the management of agricultural produce, from seed preparation, planting, maintenance, harvesting through to post-harvesting. The aim is to create the safety standards for both domestic and international markets while minimizing environmental damage. According to Akkaya et al. (2005), GAP is based on the principles of risk prevention, risk analysis, sustainable agriculture using integrated pest management (IPM) and integrated crop management (ICM) for the continuous improvement of farming systems. Furthermore, according to Amekawa (2009), the GAP standards hold the potential to actualize a broader inclusion of small-scale producers toward the attainment of social, economic and environmental benefits.

The food safety and Quality Management System (QMS) scheme is a management system to prevent, eliminate or minimize physical, chemical and biological hazards and to produce fresh fruits and vegetables that are pest-free and with marketable quality from the farm through the distribution channels for the markets and/or processing. Specifically, Thailand has been developing its own QMS based on existing international standards (Salakpetch, 2005). **Table 1** lists the QMS for on-farm quality and safety for Thai produce.

The standards as mentioned earlier are, however, haphazardly implemented with products sold in the domestic market, giving rise to a lack of confidence in the safety of local food products among many Thai consumers. To address this issue, the GAP could also effectively be employed to improve the local food safety (Wongprawmas, 2014).

According to Subervie and Vagneron (2012), certified farmers are presented with more opportunities to sell larger quantities of their agricultural products due to the exporters' confidence and the improved product quality and quantity. With the liberalization of agricultural markets, the number of small-scale vegetable farmers for both domestic and export markets is steadily increasing. Dinham (2003) documented that the global demand for vegetables of city dwellers in many developing countries is enormous; and that farmers in peri-urban or rural areas with good access to the cities (i.e., good location) are afforded an ever-growing market for their offerings. Nevertheless, with rising quality standards and traceability requirements, it is a significant challenge for small-scale farmers to benefit from this non-traditional agricultural trade.

2. Research Methodology

2.1. Sampling Design

This empirical research was conducted between 2014–2015 with the focus on fresh asparagus and processed (canned) sweet corn products for export markets. Specifically, the sampling design involves three steps: First, two provinces of Thailand (i.e., Phetchabun and Kanchanaburi) were purposively selected since the two provinces are, respectively, among the major producers of asparagus and sweet corn in Thailand. Next, a cluster sampling was applied for selection of districts from the two provinces, and finally, a simple random sampling was further practised to select both asparagus and sweet corn farming households/farmers.

Table 1: QMS for on-farm quality and safety of fresh produce.

Quality and safety items	Quality objectives
1. Water quality	Physical, chemical and biological safety
2. Cultivation area	Physical, chemical and biological safety
3. Pesticide issues	Physical, chemical and biological safety
4. On-farm stock and transport of produce	Physical, chemical and biological safety
5. Crop protection	Free of pests
6. Production process	Quality to meet customer satisfaction
7. Postharvest handling	Quality to meet customer satisfaction
8. Records	Retraceable

2.2. Sample Size

The sample size was determined using a simplified formula proposed by Yamane (1967) and tabulated in **Table 2**. According to the Department of Agricultural Extension (2015), there were 1,077 and 1,335 asparagus and sweet corn farming households in the provinces of Phetchabun and Kanchanaburi, respectively. The estimated total sample size was thus 147 farming households, consisting of 66 asparagus and 81 sweet corn farming households/farmers.

2.3. Data Collection

The primary data were gathered from direct observation, questionnaire survey and in-depth interview with the participating asparagus and sweet corn farmers. Meanwhile, the secondary data are the generic information on the production and marketing of Thai vegetables from public archives and published literature. The sources of the second data included the Department of Agricultural Extension, the Department of Internal Trade, the Office of Agricultural Economics, the Thai Fruit and Vegetable Producers Association, the Ministry of Agriculture and Agricultural Cooperatives, the Bank of Thailand, and the Customs Department of Thailand.

2.4. Data Analysis

Data were analyzed with the binary logistic regression model using the Statistical Package for Social Science (SPSS) program (version 14). The descriptive statistics included the mean, percentage, standard deviation (SD), frequency, weighted average index (WAI), and T-test. Also, five assessment levels (AL) were used: very low (VL), low (L), moderate (M), high (H) and very high (VH). The weighted average index (WAI) associated with the five assessment levels are 0.01–0.20 for VL, 0.21–0.40 for L, 0.41–0.60 for M, 0.61–0.80 for H, and 0.81–1.00 for VH. Satisfaction on the quality of agricultural information was assessed by using WAI (Wonnacott and Wonnacott, 1990) as follows:

$$WAI = [fSs(1.0) + fS(0.8) + fN(0.6) + fD(0.4) + fSd(0.2)] / N \quad (1)$$

where,

WAI	=	Weighted Average Index;
fSS	=	Frequency of strongly satisfied;
fS	=	Frequency of satisfied;
fN	=	Frequency of neutral;
fD	=	Frequency of dissatisfied;
fSD	=	Frequency of strongly dissatisfied; and
N	=	Total number of observation.

According to Hair et al. (1998), the binary logistic regression is a statistical technique in which the probability of a dichotomous result, such as the adoption or non-adoption, is related to a set of explanatory variables that are hypothesized to influence the outcome. Thus, this regression technique is the most appropriate analytical tool to examine and identify the determinants of GAP adoption.

2.5. Model specification

The logistic regression model characterizing the adoption of GAP by the vegetable farmers is expressed in Eq. (2), assuming a 95% confidence level ($p < 0.5$) (Israel, 1992).

$$Y = \beta_0 + \beta_i X_i + e_i \quad (2)$$

Table 2: Sample size of asparagus and sweet corn farming households.

Produce	Total farming households (% of total)	Sample Size (households)
Asparagus	1,077 (45%)	66
Sweet corn	1,335 (55%)	81
Total	2,412 (100%)	147

Source: Department of Agricultural Extension (DOAE).

Where Y is the dependent variable, β_0 is a constant, β_i is the slope or regression coefficient, X_i is the vector of independent variables and e_i is the error term.

A positive coefficient (β_i) indicates an increase in log odds, i.e., the likelihood of GAP adoption. The odds ratio (Exp(β)) is a monotonic transformation, which means the odds increase as the probability increases and vice versa. The maximum likelihood estimates of the parameters in the logistic regression model were used to identify the factors influencing the vegetable farmers' adoption of GAP. Wald statistic $[(B/se)^2]$ is the square of the t-statistic, which was used to test the significance of the individual coefficient. Each Wald statistic was compared to x^2 distribution with 1df. The Nagelkerke R-squared and the Cox and Snell R-squared were used to determine the usefulness of explanatory variables in predicting the response variables (Hair et al., 1998).

Table 3 presents two groups of independent variables that are hypothesized to influence the decisions on the GAP adoption and export of vegetables. The first group (i.e., the QMS factors) includes water quality, cultivation area, pesticides and chemicals, production management, harvest and postharvest, transport and storage, personal hygiene, and data recording. All else being equal, these factors are expected to have a positive impact on the farmers' decisions on the adoption of the standard and vegetable export. Meanwhile, the second group (i.e., the demographic factors) includes, e.g., gender, education, marital status, location, age, experience, household size, labor and income. These demographics have an indirect effect on the household's access to productive resources and also shape the decision process within the household. This type of variable is often a latent feature and cannot be observed or measured directly. Therefore, it must indirectly measure and must believe that those internal features will determine whether a result behaves either under suitable conditions. For example, more experience may affect decision making. The descriptive statistics of the independent variables under study is also presented in **Table 3**.

Table 3: Descriptive statistics of the independent variables.

Variables	Coding	Mean	(SD)	Min.	Max	Expected sign
Quality management system factors						
Water quality	Assessment level & WAI	44.75	(4.34)	31.00	50.00	+
Cultivation area	Assessment level & WAI	27.46	(10.89)	10.00	50.00	+
Pesticides and chemicals	Assessment level & WAI	54.12	(8.24)	38.00	71.00	+
Production management	Assessment level & WAI	44.93	(10.28)	24.00	60.00	+
Harvest and postharvest	Assessment level & WAI	33.14	(13.38)	0.00	45.00	+
Transport and storage	Assessment level & WAI	30.23	(6.13)	18.00	35.00	+
Personal hygiene	Assessment level & WAI	21.60	(5.76)	10.00	30.00	+
Data recording	Assessment level & WAI	14.60	(13.96)	0.00	45.00	+
Demographic factors						
Gender	Male = 1, Female = 0	1.51	(0.50)	1.00	2.00	+/–
Education	Literate = 1, Illiterate = 0	2.35	(1.06)	1.00	6.00	+
Marital status	Married = 1, Single = 0	2.17	(0.79)	1.00	5.00	+/–
Age	Number of years	51.45	(9.83)	28.00	80.00	–
Experience	Number of years	6.04	(4.31)	1.00	20.00	+/–
Household size	Number of persons	4.01	(1.67)	1.00	11.00	+/–
Labor force	Number of persons	1.97	(0.96)	0.00	5.00	+/–
Water source	Ground = 1, no = 0	2.65	(1.14)	2.00	5.00	+/–
Location	Plain = 1, No = 0	1.93	(1.34)	1.00	6.00	+/–
Land holding	Area (Rai)[1]	4.61	(5.09)	1.00	40.00	+/–
Income[2]	Amount of farm income (Baht/Rai)	53853.15	(50680.15)	10000.00	336000.00	+

[1] 1 hectare = 6.25 rai.
[2] 1 USD = 35.00 Thai baht.

3. Research Results

3.1. Benefits from Good Agricultural Practices

Table 4 presents a summary of the benefits associated with GAP adoption cited by the participating asparagus and sweet corn farmers. The benefits could be categorized into five groups: knowledge, social, economic, environmental and institutional.

On the aspect of knowledge, the asparagus farmers benefitted more, as indicated by the higher percentages, in comparison with the sweet corn counterparts. This phenomenon could be attributed to the fact that asparagus is mostly cultivated to export fresh, where food safety and professional practices are prerequisites. This, in turn, necessitates the acquisition of knowledge and training on GAP by the asparagus growers. On the other hand, the sweet corn harvests undergo processing prior to export and thus no GAP certification is required of the corn farmers. This contributed to the sweet corn farmers' perceptions that the GAP training was of less benefit to them.

Conversely, the social connection benefits reaped by the sweet corn farmers were higher than the asparagus farmers, as indicated by the higher percentages. This is probably due to the considerably larger population of sweet corn growers and the more prevalence of groups of local growers of sweet corn that regularly meet for discussion. Nonetheless, by comparison, the asparagus farmers benefitted more in terms of the economic, environmental and institutional aspects.

Table 4: Summary of Benefits from the GAP Adoption.

Benefits	Asparagus		Sweet corn		Total	
	f	%	f	%	f	%
1. Knowledge						
Seed variety selection	49.00	74.24	26.00	32.10	75.00	51.02
Water management	31.00	46.97	24.00	29.63	55.00	37.41
Farmland preparation	61.00	92.42	21.00	25.93	82.00	55.78
Organic& inorganic fertilizer use	66.00	100.00	44.00	54.32	110.00	74.83
Planting technique	53.00	80.30	20.00	24.69	73.00	49.66
Postharvest practices	66.00	100.00	19.00	23.46	85.00	57.82
Marketing opportunity	53.00	80.30	18.00	22.22	71.00	48.30
2. Social network						
Informational enhancement	60.00	90.91	75.00	92.59	135.00	91.84
Idea discussion and sharing	13.00	19.70	19.00	23.46	32.00	21.77
Co-learning	10.00	15.15	21.00	25.93	31.00	21.09
3. Economic aspect						
Yield improvement	66.00	100.00	78.00	96.30	144.00	97.96
Production cost reduction	65.00	98.48	44.00	54.32	109.00	74.15
Income enhancement	64.00	96.97	19.00	23.46	83.00	56.46
Access to market	51.00	77.27	17.00	20.99	68.00	46.26
4. Environmental aspect						
Soil quality improvement	66.00	100.00	79.00	97.53	145.00	98.64
Water pollution avoidance	66.00	100.00	17.00	20.99	83.00	56.46
Health hazards prevention	66.00	100.00	21.00	25.93	87.00	59.18
5. Institutional aspect						
Training	44.00	66.67	68.00	83.95	112.00	76.19
Demonstration plot	26.00	39.39	12.00	14.81	38.00	25.85
Field visit	40.00	60.61	19.00	23.46	59.00	40.14
Participation in farmers' groups	19.00	28.79	9.00	11.11	28.00	19.05

Source: Field Survey, 2014.

The benefits of GAP are multifold. The pollutant residues in the soil, water and air would be reduced, and thus the environmental degradation halted or reversed. Also, the adopting farmers' financial conditions would be improved due to the lower production cost partly attributable to the smart use of chemicals and pesticides; and to the higher prices commanded by the GAP vegetables relative to the non-GAP (i.e. conventional) vegetables. Moreover, the farmers are better equipped with the knowledge and information on the organic fertilizers, farm management and water management. According to Athipanyakul and Pak-Uthai (2012), the improved farmer's knowledge associated with the program participation could be a precursor of the program adoption. More importantly, despite the circumventive advantage of GAP over the intra-ASEAN NTBs, the participation in the GAP program of Thai vegetable farmers is still limited because the GAP implementation is relatively costly and time-consuming.

3.2. Vegetable farmers' ability to abide by the GAP standards

Table 5 tabulates and compares the average WAI on the GAP activities undertaken by the participating asparagus and sweet corn farmers. The respondents were asked to score the GAP activities based on their contributions on a scale of 1 (lowest) to 5 (highest). The WAI is then calculated, and the assessment levels (AL) are given. Overall, the WAI belonging to the asparagus farmers were higher than those of the sweet corn farmers at the 99% confidence interval.

3.2.1. Water quality

The issue of water quality received the very high (VH) assessment level for both asparagus and sweet corn farmers. The findings suggest that the water source was clean and free from toxic or harmful contaminants. Also, it could be inferred that the participating farmers utilized the water efficiently and effectively such that the plants were properly and adequately hydrated. Furthermore, water contamination could be avoided.

3.2.2. Cultivation area

On the issue of cultivation areas, both groups of the participating farmers received the moderate (M) assessment level. The direct observations, however, revealed that the cultivation areas were well-managed whereby the soil fertility was regularly maintained and improved by the introduction of organic matters, including compost, manure and crop rotation. Also, ground cover plants were grown for soil erosion reduction and soil pH adjustment. Moreover, a combination of organic and chemical fertilizers was utilized in accordance with the plants' needs.

3.2.3. Pesticides and chemicals

The high (H) assessment level on the issue of pesticides and chemicals implied that both groups of the participating vegetable growers were knowledgeable of pesticides and chemicals and their use. The pesticides and chemicals were properly and carefully applied to avoid damaging the crops, animals and the environment.

Table 5: Average WAI for the GAP activities undertaken by the participating farmers.

GAP activity	Asparagus		Sweet corn		T-test	Sig.
	WAI	AL	WAI	AL		
Water quality	0.94	VH	0.86	VH	6.567	0.000
Cultivation area	0.55	M	0.55	M	0.069	0.945
Pesticides and chemicals	0.72	H	0.72	H	0.093	0.926
Production management	0.80	H	0.71	H	3.338	0.001
Harvest and postharvest	0.90	VH	0.61	H	7.465	0.000
Transport and storage	0.99	VH	0.76	H	12.108	0.000
Personal hygiene	0.76	H	0.69	H	2.542	0.012
Data Recording	0.22	L	0.41	M	-3.936	0.000

Source: Field Survey, 2014.

3.2.4. Production management

Both groups received the high (H) assessment level on production management. The survey revealed that proper plant species were pre-selected and the strategic spacing was adopted to avoid the spread of the pests. In addition, plant diseases were either naturally controlled using biological predators or eliminated by burning.

3.2.5. Harvest and postharvest

On the issue of harvest and postharvest, the asparagus farmers scored very high (VH) on the assessment level while the sweet corn counterparts received the high (H) assessment level. The small disparity is attributable to the fact that the fresh asparagus are destined for export markets; therefore, the harvest and postharvest activities have to be carried out in a timely and hygienic manner before distribution. On the contrary, the sweet corn products are processed and canned before export, and thus the care required is relatively less.

3.2.6. Transport and storage

The asparagus farmers scored very high (VH) on the assessment level while the sweet corn counterparts received the high (H) assessment level on the transport and storage aspect. The findings suggest that both groups have an efficient transport and storage system of the crops. The slight disparity is because the asparagus products are exported fresh and thus the highly efficient storage and delivery are of paramount importance. Meanwhile, the survey found that the majority of the sweet corn farmers were contract farmers and therefore good transportation and storage was pre-arranged by the food processing plants.

3.2.7. Personal hygiene

The assessment level on personal hygiene of both asparagus and sweet corn farmers was high (H). The finding is attributable to the fact that both groups of the participating farmers were properly and adequately trained by the authorities. In addition, the participating farmers were capable of proper operation of the farm tools and machines.

3.2.8. Data recording

On the issue of data recording, the findings were dismal since the asparagus and sweet corn farmers respectively received the low (L) and moderate (M) assessment grades. The disparity was due to the fact that the corn farmers were contract farmers under financial obligations with the employer (i.e., the food processing company), necessitating them to maintain complete records of the financial transactions.

All in all, both groups of the participating farmers received either the high (H) and very high (VH) assessment grades in almost all aspects, except for the data recording; as a result, the farmers cannot know the real cost of production. The findings indicate that both vegetable farmer groups are capable of abiding by the GAP production standards.

3.3. Influencing factors of the GAP adoption

Table 6 tabulates the binary logistic regression results depicting the factors influencing GAP adoption by the participating asparagus and sweet corn farmers, given the 95% and 99% level of confidence. **Table 6** also presents the coefficients (β), Wald statistics and exponential betas (i.e., odds ratios) of the independent variables under study. The Cox and Snell R-squared and Nagelkerke R-squared results of 53.1% and 86.4%, respectively, confirm the association between these independent variables and the GAP adoption of the vegetable farmers. The statistical model has a strong explanatory power, as indicated by the Chi-square statistic and $p < 0.000$.

It was found that the factors that were significantly associated with the GAP adoption ($p < 0.05$) included the cultivation area ($\beta = 1.015$), harvest and postharvest (1.896), transport and storage (1.799), marital status (–5.957) and income (7.314).

Specifically, the logit coefficient (β) for the cultivation area variable was 1.015. Also, the cultivation area factor was positively and significantly associated with GAP adoption ($p < 0.05$). The finding suggests that an increase in the cultivation area by one unit will increase the adoption of GAP by 1.015 unit. Simply stated, the more arable land available, the larger the area that would be allocated under the GAP cultivation.

Meanwhile, the logit coefficient (β) for harvest and postharvest was 1.896. This factor was positively and significantly associated with the GAP adoption ($p < 0.05$). In addition, the GAP adoption would increase with

Table 6: Factors influencing the adoption of GAP by the participating vegetable farmers.

Variables	Coefficient (β)	Wald stat [(B/se)²]	Odds ratio Exp (β)	Sig
Intercept	50.885	2.335	1.256E22	0.126
Quality management system factors				
Water quality	0.184	0.412	1.202	0.521
Cultivation area	1.015*	4.268	0.362	0.039
Pesticides and chemicals	0.057	0.063	1.059	0.801
Production management	0.677	2.089	1.968	0.148
Harvest and postharvest	1.896*	3.746	0.150	0.050
Transport and storage	1.799*	4.207	6.042	0.040
Personal hygiene	–0.186	0.631	0.831	0.427
Data Recording	–0.217	0.648	0.805	0.421
Demographic factors				
Gender (male = 1, female = 0)	–1.481	0.665	0.227	0.415
Education (literate = 1, illiterate = 0)	0.973	0.141	2.646	0.707
Marital status (married = 1, single = 0)	–5.957*	3.820	0.003	0.050
Location (plain = 1, otherwise = 0)	–3.955	2.479	0.019	0.115
Age (years)	0.000	0.000	0.999	0.995
Experience (years)	–0.743	1.924	0.476	0.165
Household size (persons)	–1.390	2.210	0.249	0.137
Labor force (persons)	1.668	1.922	5.300	0.166
Water source (underground = 1, no = 0)	–2.418	0.773	0.089	0.379
Land holding (rai)	–1.072	0.045	0.342	0.831
Income (Baht)	7.314**	5.516	0.001	0.019

Cox and Snell R squared = .531; Nagelkerke R squared = .864; –2 log likelihood = 28.923a; Chi-square = 111.291; df = 20; p = .000.

Note: * Significant at 95% confidence interval, ** Significant at 99% confidence interval.

Source: Field Survey, 2014.

the improvement in the harvest and postharvest standards which in turn reduce the waste. The finding is consistent with Kader (2002).

Transport and storage was significantly encouraging the GAP adoption ($p < 0.05$). Its logit coefficient (β) was 1.799. The GAP adoption by the vegetable farmers would increase with an increase in the transport and storage standards. This is attributable to the fact that most GAP products require efficient transport and storage for the maintenance of product quality, safety and freshness. This result is in line with Kaliyan and Morey (2009).

Interestingly, the marital status was found to be significantly discouraging the GAP adoption ($p < 0.05$). Its logit coefficient (β) was –5.957., indicating that the GAP adoption would decrease in the case of a married individual. According to KAMA (1998), the majority of GAP farmers were young and single partly because the successful GAP farming requires considerable time and devotion.

The income factor was significantly positively associated with GAP adoption ($p < 0.01$). Its logit coefficient (β) was 7.314, suggesting that GAP adoption would increase with an increase in income by one unit. According to Timprasert et al. (2014), vegetable production is a lucrative livelihood for Thai farmers due to the short payback period. Nevertheless, due to the high production cost and the price similarity between the GAP and non-GAP yields for crops with low maintenance requirement, the adoption of GAP is thereby limited to a narrow range of products, consistent with Defrancesco et al. (2008).

In short, the income factor is the most important driver that influences the GAP adoption of vegetable farmers. Also, the possibility of higher income contributed to the improved QMS concerning the harvest, transport and cultivation area. Specifically, a higher income would encourage farmers to harvest and retain their produce in a high-standard manner. Besides, the cultivation area would be contamination-free. To effectively raise the GAP adoption in the country, exporters and relevant government agencies should make GAP compulsory for all vegetable farmers, in addition to the economic incentives of the GAP program.

3.4. Factors influencing the cultivation decision for export

Table 7 presents the binary logistic regression results about the factors influencing the vegetable farmers' decision to produce for export markets ($p < 0.05$). The table also presents the coefficients (β), Wald statistics and exponential betas of the independent variables. The Cox and Snell R-squared and Nagelkerke R-squared results of 57% and 76.7%, respectively, confirm the correlation between the independent variables and the export decision. The statistical model has a strong explanatory power, as indicated by the Chi-square statistic and $p < 0.000$.

The factors that were statistically associated with the export decision ($p < 0.05$) included the harvest and postharvest (β = 0.156), transport and storage (0.245), personal hygiene (0.312), data recording (0.319), water source (–2.244) and location (2.245).

The logit coefficient (β) for harvest and postharvest was 0.156. This factor was significantly positively correlated to the decision to cultivate for export of the vegetable farmers ($p < 0.05$). The findings mean that an increase in the harvest and postharvest standards by one unit would be translated into an increase in the decision to cultivate for export by 0.156 unit. This is in line with Kader (2002). This is because of the good harvest and a post-harvest system can control the quality of products and have more chances to export and obtain a high return.

Table 7: Factors influencing the vegetable farmers' decision to cultivate for export.

Variables	**Coefficient (β)**	**Wald stat [(B/se)²]**	**Odds ratio Exp (β)**	**Sig**
Intercept	14.592	4.896	2173946.167	0.027
Quality management system factors				
Water quality	0.165	1.378	1.179	0.240
Cultivation area	0.014	0.030	1.014	0.863
Pesticides and chemicals	–0.133	2.017	0.876	0.156
Production management	–0.036	0.150	0.965	0.699
Harvest and postharvest	0.156*	2.879	0.855	0.050
Transport and storage	0.245*	4.619	0.783	0.032
Personal hygiene	0.312*	4.744	0.732	0.029
Data Recording	0.319**	12.566	1.375	0.000
Demographic factors				
Gender (male = 1, female = 0)	0.145	0.045	1.155	0.831
Education (literate = 1, illiterate = 0)	0.809	0.802	2.247	0.370
Marital status (married = 1, single = 0)	–1.338	2.345	0.262	0.126
Age (years)	0.006	0.026	1.006	0.872
Experience (years)	–0.026	0.133	0.974	0.716
Household size (persons)	0.033	0.023	1.034	0.879
Labor force (persons)	0.323	0.409	1.381	0.522
Water source (underground = 1, no = 0)	–2.244*	4.031	0.106	0.045
Location (plain = 1, no = 0)	2.245*	5.454	9.428	0.020

Cox and Snell R squared = .574; Nagelkerke R squared = .767; –2 log likelihood = 72.292; Chi-square =125.342; df = 17; p = .000.
Note: * Significant at 95% confidence interval, ** Significant at 99% confidence interval.
Source: Field Survey, 2014.

Transport and storage were significantly positively correlated to the export decision ($p < 0.05$). Its logit coefficient (β) was 0.245. This means that an increase in the transport and storage standard by one unit would be translated into an increase in the decision to cultivate for export by 0.245 unit. The finding is consistent with Paull (1999). According to the finding, good transport and storage have a significant impact on its safety and quality.

Personal hygiene was significantly positively correlated to the export decision ($p < 0.05$). Its logit coefficient (β) was 0.312. This means that an increase in personal hygiene by one unit would be translated into an increase in the decision to cultivate for export by 0.312 unit. The findings are consistent with Pollard et al. (2002). Personal hygiene is one of the most important steps a farmer can take to prevent contamination of their vegetables with foodborne pathogens and have more chances to export the products.

Data recording was significantly positively correlated to the export decision ($p < 0.01$). Its logit coefficient (β) was 0.319. This means that an increase in data recording by one unit would increase in the decision to cultivate for export by 0.319 unit, consistent with Zwald et al. (2004). Also, good maintenance of records facilitates the production forecast and product traceability.

Interestingly, the water source factor was negatively and significantly associated with the export decision ($p < 0.05$). Its logit coefficient (β) was –2.244, implying that a decrease in the reliance on underground water (in other words, a shift to the irrigation system) would contribute to an increase in the production of GAP vegetables for export by 2.244 unit. The irrigated water sources are of reliable quality and quantity relative to the underground water. According to Ayers and Westcot (1985), exporting vegetable farmers need a good supply of water for the steady production of vegetables to meet the market demand.

Location was positively and significantly correlated to the export decision ($p < 0.05$). Its logit coefficient (β) was 2.245, suggesting that an increase in the lowland plains utilization by one unit would increase in the decision to cultivate for export vegetables by 2.245 unit. According to Lucas and Chhajed (2004), good locations are crucial for the exporting vegetable farmers for consistent supply of vegetables to the markets. All in all, location (i.e., the lowland plain) is the most influencing factor of the export decision of the participating vegetable farmers. This is because lowland plains are typical of naturally accumulated sediment fertile soils. Also, most plains have access to abundant water supply or are near the irrigation system. Ideal locations also refer to those with efficient transportation and close to the purchasing centre, which is vital for the export sales of fresh produce, e.g., asparagus.

4. Discussion and interpretation

Amidst the free trade negotiations and agreements to lower tariffs and remove trade barriers, an increasing number of countries have resorted to non-tariff barriers (NTB) as the entry-barrier strategy to protect the domestic industry, e.g., import volume restriction, sanitary and phytosanitary (SPS) requirements. In the 10-nation ASEAN Economic Community (AEC) bloc, an SPS certification is required for the import and export of vegetables and fruits between member countries.

Food safety is a major concern for all food producers and handlers. Microbial contamination that results in unsafe food is the focus of much of this concern. Contamination can come from many sources: the use of unsanitary harvesting and handling equipment, contamination caused by chemical-infested irrigation water that is due to heavy and unsafe use of pesticides upstream, inadequate personal hygiene by employees, improper fertilizer and soil amendment use, and a variety of other obvious and not-so-obvious sources. Prevention of contamination must begin on the farm and continue through to the huller/Sheller and handler operations. It is critical that Good Agricultural Practices (GAPs) are in place to ensure the contamination load on almonds is at a level low enough.

To tackle the NTB issue, it is economically and environmentally sensible for Thai vegetable farmers to adopt the concept of good agricultural practices (GAP), which, if properly applied, results in food products that are safe without contamination and wholesome for consumers or further processing. In addition, GAP contributes to the improved productivity, in particular for the small-scale farmers'.

Nevertheless, Thai vegetable exports are afflicted with pesticide residues and phytosanitary issues. This fact is attributable to the heavy reliance of the country's agricultural sector on pesticides and chemicals to protect the crops and increase yields (Panuwet et al., 2012). Furthermore, the production systems are not standardized, and there is no quality control. The vegetable growers' and distributors' understanding of food safety standards and phytosanitary measures is severely limited.

This research has focused on the asparagus and sweet corn growers in Thailand's Phetchabun and Kanchanaburi provinces. Phetchabun province is the country's major producer of fresh asparagus for export and Kanchanaburi has significant swaths of arable land allocated for the cultivation of sweet corn. The sweet corn yields are supplied to the exporting food processing plants. In the analysis, this empirical research has utilized the binary regression model to identify the influencing factors of the GAP adoption and the export decision of the participating vegetable farmers.

The research findings revealed that income is the most important influencing factor in the participating vegetable growers' adoption and implementation of GAP. In addition, the higher income from the GAP vegetables led to better harvest and postharvest, better transport and storage, and more efficient management of the cultivation area. This is consistent with Kramol et al. (2005), who documented that the GAP tomato growers were more successful in improving the productivity and income through higher quality produce vis-à-vis the non-GAP tomato farmers.

It is seen from the research that in case of fresh vegetables export, the farmers who grow the asparagus with GAP obtain price higher than the farmers who grow without-GAP. This is because the importers are more confident in quality of GAP products and are willing to pay more for safe products.

However, there are many others influencing factors influencing growers to adopt the GAP, for example, increase in cultivation area, improvement in the harvest and post harvest standards, efficient transportation and storage for maintenance of product quality. However, requirement of considerably higher time and devotion in GAP farming pose challenge to its adoption.

Meanwhile, the good location factor is the most important influencing factor in the participating vegetable farmers' decision to grow for export since good locations (i.e., lowland plains) typically are abundant with water and fertile soil. In addition, ideal locations refer to those with efficient transportation and close to the purchasing center, which is vital for the export sales of fresh produce.

In addition, the others influencing factor for farmers to decide to grow for export are harvest and post harvest standards, transport and storage standard, high personal hygiene, good data recording and good supply of water.

It can be concluded that good agricultural practices are important for the most important thing that is human health followed by the economic value of the products. Plantation crops are highly income generating if managed properly. Farmers should adopt and implement GAPs in farming in order to improve the quality of products and reduce the effect from Non-tariff Barrier and while growing more environment-friendly.

More importantly, to encourage greater adoption of GAP, price incentives, as well as price stability and market certainty via contract farming, should be utilized (Sriwichailamphan et al., 2007). To increase the GAP farms, Government should motivate growers by improving water quality, training the way to manage farm and on how to use pesticides and chemicals in the right way, and developing the infrastructure. To enhance capacity of farmers and to reduce agricultural production costs, government's role is crucial in the development of irrigation systems and water storage dams for agriculture. Moreover, agricultural zoning is another alternative to drive the success of a GAP program. The agricultural zoning method is commonly employed to preclude the misuse of agricultural land for unrelated developments (Coughlin, 1991). Farming in the appropriate area or Zoning will contribute significantly to farmers to be able to produce according to the potential of the area. In addition, it should support farmers to be in group in order to easily disseminate the knowledge such as on how to decrease the cost and increase the yield and support each other. Another strategy to successfully raise GAP adoption among the Thai agriculturists is through the exporters and relevant government agencies making the certification compulsory. GAP helps in controlling abuses of natural resources, and having regional GAP is one important aspect of securing field to fork health and has important role in avoiding ground water contamination through participation of local communities.

Competing Interests

The authors have no competing interests to declare.

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