

Food safety assurance system for fresh produce production in Thailand: a review

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Received: 22 January 2013 / Accepted: 16 December 2013

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REVIEW ARTICLE

Abstract

In 2004, the Thai government enacted a food safety policy, 'from-farm-to-table', to ensure food safety throughout the food chain. Several food safety assurance systems such as good agricultural practices (GAP) are employed to control and monitor food safety. Nevertheless, a lack of confidence in food safety of products in the domestic market still exists. This study aimed to describe and analyse the current situation of GAP standards implemented in fresh produce production in Thailand. A mixed explorative and descriptive approach was used by reviewing literature and using multidimensional scaling to draw a subjective perceptual map of the relative position of the set of GAP standards adopted in Thailand. Food safety law and regulations were discussed with a comparative analysis of the three kinds of GAP standards applied in Thailand. The subjective perceptual map of the different GAP standards shows that the standards may be positioned with reference to two dimensions: 'trustworthiness' and 'usefulness for the business'. The problem of GAP implementation in Thailand is rooted in a lack of knowledge and understanding of principles and the perception of advantages of GAP adoption among stakeholders. The national GAP of Thailand, Q-GAP, is the most widely adopted standard. However, improvement of credibility of this standard is urgently required.

Keywords: good agricultural practices, perceptual map, standards

1. Introduction

Food safety has gained high public attention over the last decade because of a series of food scandals such as several outbreaks of *Escherichia coli* contamination in fresh produce, such as fresh spinach in the USA in 2006 (Grant *et al.*, 2008) and bean sprouts in Germany in 2011 (Goetz, 2011). The lack of adequate food safety does not only result in high costs for the industry, but it also has significant impact on social welfare. Therefore, many governments and private organisations have been trying to set up and implement several schemes and programmes to strengthen food safety systems. Since 2004, the Thai government enacted a food safety policy named 'from-farm-to-table' or 'from-farm-to-forks' aimed at ensuring food safety monitoring and control system throughout the food chain and subsequently announced national strategic plan entitled 'Standard, quality and safety for agricultural commodities and food products' to be implemented during

the period 2010-2013 (ACFS, 2011b). Several actions have been undertaken to achieve the policy strategic objectives, for example the draw up of mandatory regulations such as minimum residue level based on the Codex Alimentarius and safety requirements for agricultural commodities and food products, and the promotion of a national 'good agricultural practice' (GAP) policy to reduce agrochemicals use. Furthermore, there are many attempts to set up food safety assurance systems (FSAS) as they are considered an efficient tool to manage, monitor and control the quality and safety of food production (e.g. Caswell, 1998; Golan *et al.*, 2004; Hammoudi *et al.*, 2010; Henson and Humphrey, 2009; Loureiro and Umberger, 2007). Currently, many public and private agencies have initiated various voluntary certification schemes as a mechanism to establish effective food quality and safety management systems in food production, processing, preservation and distribution (Arpanutud *et al.*, 2009) with the aim to help the adopters not only to comply with regulations, but also to go beyond

the mandatory level of food safety and to better meet customer's requirements. Three main voluntary food safety assurance schemes focused on farming are currently available in Thailand: (1) GLOBALGAP which is a private standard and currently adopted predominantly by farms oriented to the EU export market; (2) ThaiGAP that is a private standard mainly adopted by farms focused on exports towards other foreign markets; and (3) national GAP (Q-GAP) that is a national public standard designed to be applied to products sold in domestic and Asian markets.

However, it is worth noting that there are high discrepancy between FSAS and GAP regulations, and enforcement between the production of fresh produce for domestic and export markets. In domestic markets, most of the current standards and regulations are poorly implemented while exported products are more strictly controlled to comply with importer requirements (Oates, 2006; Takeuchi and Boonprab, 2006). This discrepancy between the enforcement of the schemes results in a low level of trust and lack of confidence of Thai consumers in the safety of local food products in the domestic market (Supaphol, 2010).

Consequently, the present situation of FSAS adoption in Thai fresh produce production for both domestic and export markets needs to be analysed. The purpose of this study is to review the literature to address the following questions. What is the present situation of FSAS adopted in Thai crop production? What are the similarities and differences among different schemes? What constraints to implementing these schemes? Finally, what are the development trends of the schemes implemented in Thailand?

These questions were approached with a focus on fresh produce production (no specific production was discussed in this study) as Thai traditional cuisine is mainly based on fresh fruits and vegetables. Consequently, contamination in fresh produce is among the principal concerns for consumers (Lippe, 2010; Vanit, 2006). The three GAPs schemes were compared in order to provide a description of the current situation and to possibly provide suggestions on how to improve the overall performance of the food safety assurance system in Thailand.

2. Methodology

This research is focused on the need to improve the understanding of the status and perspectives of FSAS adoption in the Thai fresh produce industry. The research methodology applied is based on the analysis and summarisation of secondary data, aimed at drawing a description of the past and current situation and at identifying possible trends in the future development of fresh produce production in Thailand. Given the limited

availability of quantitative data about this topic, a mixed explorative and descriptive approach was adopted.

Secondary data was collected through three different sources:

- Scientific literature databases during 1995-2012 (e.g. Science Direct, SAGE Journals Online, Kasetsart Journal, etc.), using the following keywords: 'food safety', 'assurance system', 'quality management system', 'good agricultural practice', and 'fresh produce'.
- Reports, which are available from national (e.g. Department of Agriculture (DOA), National Bureau of Agricultural Commodity and Food Standards, Ministry of Public Health, etc.) and international organisations (e.g. Food and Agriculture Organization (FAO), Food & Fertilizer Technology Center, the United Nations Conference on Trade and Development).
- Others (e.g. magazines, press articles and internet) to obtain background information on this topic.

Statistical data was collected mainly from sources such as GAP DOA online and Thai official reports.

Based on the review of the previous literature, the authors' subjective perceived relative position of the set of GAP standards adopted in Thailand is presented, drawing a perceptual map by using multidimensional scaling (MDS). A decompositional approach to MDS is utilised, as it enables the use of an overall perceived similarity measures and the identification of the main underlying perceptual dimensions determining the positions of the objects in this multidimensional space (Hair *et al.*, 2010).

The aim of MDS is to transform the researcher's judgment of overall similarity of the GAP standards into multidimensional space. The procedure is as follow. Firstly, a set of 21 unique pairs of the 7 variations of GAP standards (GLOBALGAP option 1; GLOBALGAP option 2; ThaiGAP level 1, option 1; ThaiGAP level 1, option 2; ThaiGAP level 2, option 1; ThaiGAP level 2, option 2; Q-GAP) was created. Then, the researcher rated the overall pattern of similarities among the pairs of standards on a 9-point scale, with 1 being 'not at all similar' and 9 'very similar'. The matrix of the similarity ranks was created by the mdsmat model contained in the Stata 11.0 software package (StataCorp LP, College Station, TX, USA). The mdsmat model performed multidimensional scaling for Euclidean proximity data (from the matrix) with an explicit measure of similarity among standards. Subsequently, a perceptual map was created by disaggregate analysis to estimate the relative position of each standard. The dimensionality of the perceptual map was selected by looking at the Kruskal's stress measure (Kruskal and Wish, 1978) and an overall index of fit (R^2) (Hair *et al.*, 2010). In the final step, the dimensional space of the axes was identified and interpreted in terms of standard attributes. It should be noted that this perceptual map

only represents the author's subjective perceptions of the different GAP standards; therefore the maps should be considered a tools to better describe and summarise the researcher's point of view.

3. Results and discussion

Laws and regulations regarding to food safety in Thai fresh produce industry

Safety of fresh produce in Thailand is regulated by 5 ministries: Ministry of Agriculture and Cooperatives, Ministry of Public Health of Thailand, Ministry of Industry, Ministry of Commerce of Thailand and the Ministry of Natural Resources and Environment (Table 1). More than 15 laws and regulations contribute to the food safety regulatory framework from production, process, import/export and distribution to final consumers (Table 1) (ACFS, 2011b). Among them, agricultural standards act B.E. 2551 (ACFS, 2008) is the main act and the most relevant to food safety of fresh produce production. Several standards have been developed under this act, both mandatory and voluntary.

According to the divergence of enforcement in food standards, Thai's FSAS can be divided into 2 types: (1) mandatory standards, enforced by government agencies throughout Thailand in a mandatory way, aimed to satisfy the public's demand for food safety; and (2) voluntary standards, implemented by producers and firms in a voluntary way, with the objective to satisfy consumers' demand for higher quality and safety, and maintaining a competitively on the international market.

Mandatory standards

All operators involved in the food supply networks have to comply with mandatory standards but the extent to which compliance occurs depends on the level of law enforcement. The Food and Drug Administration of the Ministry of Public Health and the provincial offices of public health are responsible for legal food control operations, while the DOA of the Ministry of Agriculture and Cooperatives is responsible for food production. For primary food production, DOA controls the production process for the certification according to the exporting product. Government agencies will conduct inspections and control tests by random sampling. Monitoring of food

Table 1. Thailand's food safety law, regulations, and standards for agricultural products (adapted from ACFS, 2011a).

Stage	Main regulations	Regulation agency
Input	Plants Act B.E.2518 (A.D.1975)	DOA (MOAC)
	Fertilizer Act B.E.2518 (A.D.1975)	DOA (MOAC)
	Plant Quarantine Act B.E.2507 (A.D.1964) amended by Plant Quarantine Act (no.2) B.E.2542 (A.D.1999) and (no.3) B.E.2551 (A.D.2008)	DOA (MOAC)
	Hazardous Substance Act B.E.2535 (A.D.1992) amended by (no.2) B.E.2544 (A.D.2001) and (no.3) B.E.2551 (A.D.2008)	MOPH, MOAC, MNRE, MOI
	Protection of Plant Varieties Act B.E.2542 (A.D.1999)	DOA (MOAC)
	Agricultural Standards Act B.E. 2551 (2008)	ACFS (MOAC)
	Thai Agricultural Commodity and Food Standard (voluntary)	ACFS, DOA (MOAC)
Production and harvest	Good Agricultural Practice (voluntary)	ACFS, DOA (MOAC)
Post-harvest and distribution	Agricultural Standards Act B.E. 2551 (2008)	ACFS (MOAC)
	Standard Output Act B.E.2522 (1979)	DFT (MOC)
	Export and Import of goods into the Kingdom Act B.E.2522 (1979)	DFT (MOC)
	Food Act B.E.2522 (A.D.1979)	FDA (MOPH)
	Consumer Protection Act B.E.2522 (A.D.1979) amended by B.E.2541 (A.D.1998)	OCPB (MOPH)
	Industrial Products Standards Act B.E.2511 (A.D.1968)	TISI (MOI)
Processing, packaging and consuming	Factory Act B.E.2535 (1992)	MOI
	Good Manufacturing Practice (GMP) (Mandatory & Voluntary)	FDA (MOPH)
	Hazard Analysis and Critical Control Point (HACCP)	TISI (MOI), FDA (MOPH)
	Agricultural Standards Act B.E. 2551 (2008)	ACFS (MOAC)
	Food Act B.E.2522 (A.D.1979)	FDA (MOPH)
	Consumer Protection Act B.E.2522 (A.D.1979) and amendment B.E.2541 (A.D.1998)	OCPB (MOPH)

DOA = Department of Agriculture; MOAC = Ministry of Agriculture and Cooperatives; MOPH = Ministry of Public Health; MNRE = Ministry of Natural Resources and Environment; MOI = Ministry of Industry; ACFS = National Bureau of Agricultural Commodity and Food Standards; DFT = Department of Foreign Trade; FDA = Food and Drug Administration; OCPB = Office of The Consumer Protection Board; TISI = Thai Industrial Standard Institute.

safety in the domestic market (including imported products) is carried out by inspectors of the Ministry of Public Health using a simple test kit.

In fresh produce, the food-borne illnesses associated with agricultural chemicals (e.g. pesticide residues) and pathogenic micro-organisms contaminations (Supaphol, 2010; Takeuchi and Boonprab, 2006) are a major hazard and a principal consumer concern. Therefore, the main mandatory standards for fresh fruits and vegetable products are maximum residue limits for detected chemicals, pathogenic microorganisms and pathogenic toxins, and sanitary and phytosanitary (SPS) measures regarding agricultural commodities and food products, based on the Codex Alimentarius and international SPS agreements, respectively. In addition, 'good manufacturing practice' (GMP) mandatory standards have been established in the national law, 'Notification of the Ministry of Public Health no. 193, B.E. 2543 (MOPH, 2000)', for 54 types of food products, which is applied to all domestic manufacturers and foreign suppliers, in order to force food enterprises to ensure a minimum level of food safety according to Thai law or Codex Alimentarius.

Voluntary standards

These types of standards are not mandatory under the current law and regulations, and they should contain prescriptions that go beyond the law requirements. Therefore, individual producers or firms may decide to adopt these standards voluntarily, on the basis of both

market and internal organisation requirements. Several voluntary standards have been applied in Thailand, such as Q-GAP, ThaiGAP, GLOBALGAP, GMP, hazard analysis and critical control point (HACCP) and ISO 22000. Figure 1 shows the main voluntary standards applied in the Thai fruit and vegetables supply chain. The discussion about 3 main standards for fresh produce production: (1) Q-GAP; (2) ThaiGAP; and (3) GLOBALGAP will be provided in other sections.

Good agricultural practices schemes adoption in Thai fresh produce production

According to the definition of FAO, GAP are 'practices that address environmental, economic and social sustainability for on-farm processes, and result in safe and quality food and non-food agricultural products' (FAO, 2003). At present, GAP is not only referred to as a concept, but is predominantly recognised as a terminology used in international regulatory frameworks as private or public voluntary standards, e.g. GLOBALGAP, FAO GAP, US Department of Agriculture GAP. GAP standards consist of four basic modules: (1) food safety; (2) environmental management; (3) worker health, safety and welfare; and (4) product quality – covering production, harvesting, postharvest handling on farm and in packing house (FAO, 2003). Even though the general concept of GAP standards is the same, differences in details of practices, levels of implementation and enforcement exist among individual standards.

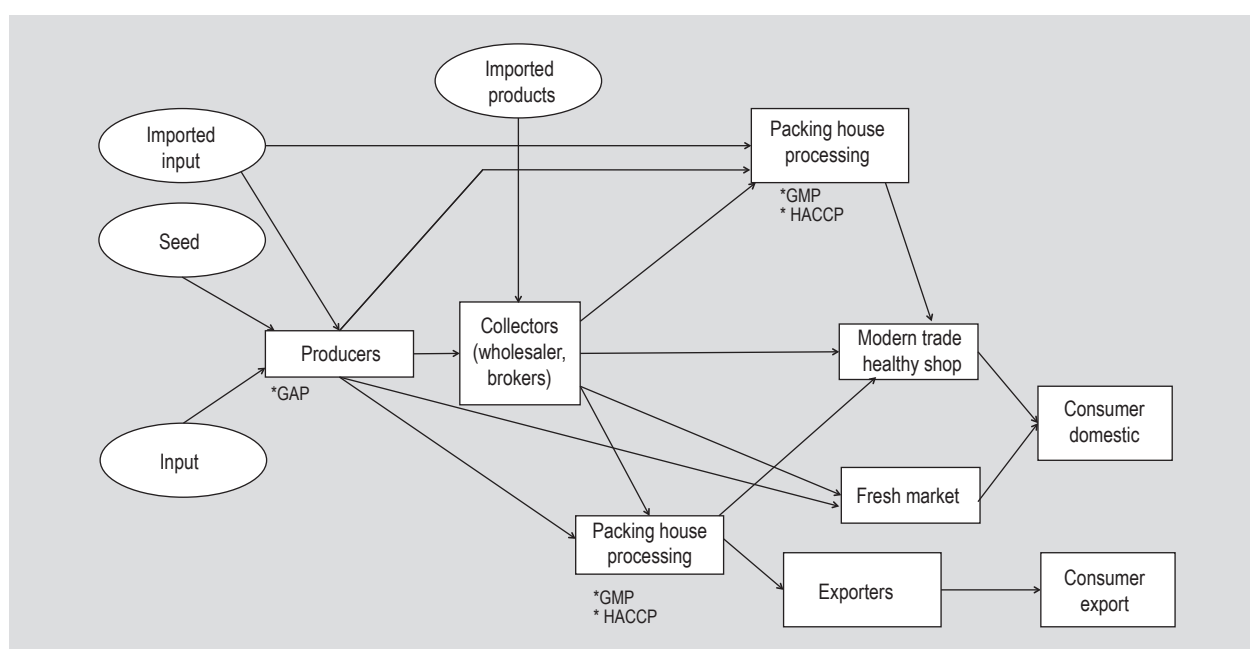


Figure 1. Food safety voluntary standards adopted at different levels of the Thai fruits and vegetables supply chain (adapted from Sastranont, 2007). GAP = good agricultural practices; GMP = good manufacturing practice; HACCP = hazard analysis and critical control point.

In the international market, GAP has been increasingly promoted by operators in the private sector, such as food processors and retailers in response to the emerging consumer demand for quality and safe food products, as well as to maintain and improve reputation and off-load legal liabilities (e.g. Fulponi, 2006; Hatanaka *et al.*, 2005; Souza Monteiro and Caswell, 2009; Sterns *et al.*, 2001). This trend has had consequences on both the Thai agri-food production and food industries, causing both Thai government and industry to respond by developing and implementing GAP schemes in agri-food production to maintain a competitiveness on the international market (Sardsud, 2007). Currently, Thai agricultural producers and operators have adopted three main GAP schemes: (1) Q-GAP (national GAP of Thailand); (2) ThaiGAP; and (3) GLOBALGAP.

GLOBALGAP

GLOBALGAP is a private international company that sets voluntary certification standards and procedures for good agricultural practices. It is based in Germany and was originally created in 1997 by a group of European supermarket chains belonging to the Euro-Retail Produce Working Group (EUREP) as EurepGAP and changed its name to GLOBALGAP in 2007. GLOBALGAP aims to establish one standard for GAP with different product applications enabling a coverage of the global agricultural production. It focuses mainly on food safety and traceability, with some requirements on worker safety, health and welfare, and environmental considerations. GLOBALGAP is a pre-farm-gate standard or on-farm standard, which covers the certification of the whole agricultural production process of the product from before the seed is planted, until the product leaves the farm. The standard also includes the control points for traceability and segregation, thus allowing for the identification of certified products out of others. However, this standard is not communicated to consumers directly, as it was principally designed as a business-to-business label (www.globalgap.org).

The GLOBALGAP series covers several standards, GLOBALGAP integrated farm assurance standard version 4.0 edition 4.0-2 (GLOBALGAP, 2013a) is most relevant to fruit and vegetable production. GLOBALGAP is comprised of several control point and compliance criteria (CPCC), divided into 3 main groups: (1) all farm base; (2) crop bases; and (3) fruit and vegetables production, which involve both on-farm and post-harvest and handling activities, including record keeping and traceability. It aims to establish a complete control and monitoring system, thereby allowing an efficient back-tracing of all registered products. There are four available GLOBALGAP certification options: options 1 and 3 require an individual certification, and options 2 and 4 allow a group certification. Individual certification is held by an individual farmer and

the verification is done annually through external inspection by third party certification bodies. Group certification is obtained by a farmer group and the verification is done through internal inspections managed by the farmer group plus one external inspection and audit per year. In addition to annual inspection, GLOBALGAP includes additional unannounced inspections by third party certification bodies as well. Certificates are valid for 12 months. Under option 3 and 4, growers are certified by obtaining an equivalent benchmarked scheme (national or local standards that has benchmarked with GLOBALGAP, for instance, ThaiGAP).

The general certification process for crop production is as follow (GLOBALGAP, 2011): producers who are interested in implementing GLOBALGAP download and read GLOBALGAP normative documents from the website; then implement CPCC on farm and implement quality management system; subsequently, producers choose a GLOBALGAP approved certification body (CB) and register for GLOBALGAP with a chosen CB; producers perform an auto-inspection using the GLOBALGAP checklist (in case of group certification and individual certification with multiple sites, producers perform Internal Quality Audit and Internal Inspections of each producers in the handling unit); their farms will be inspected by external audit by a CB – both announced and unannounced inspections – and finally the certification decision will be made by the CB.

Thai exporters are the most active in requesting their suppliers to implement GLOBALGAP. However, since GLOBALGAP is not yet necessary for the regional export market and because of its stringent regulation and the high cost of implementation, the standard is adopted by the exporters oriented towards the EU market only. In fact, there is only one Thai supplier, KC Fresh, who is a supplier member of GLOBALGAP. In December 2012, there were 277 Thai producers certified under the GLOBALGAP standards (GLOBALG.A.P., 2012). Difficulty in accessing the Internet, download of GLOBALGAP normative documents and manual, the language barrier, lack of know-how in completing required documentations and records and high certificate costs, have been documented as the main constraints for Thai producers in adopting GLOBALGAP standards (UNCTAD, 2005). In 2011, the Thai National Interpretation Guidelines for Integrated Farm Assurance Control Points and Compliance Criteria were approved by GLOBALGAP and became obligatory from February 23, 2012. This manual is written in both English and Thai and is expected to be more accessible by Thai farmers. The GLOBALGAP option 2 group certification has been introduced in Thailand in order to cope with high cost, as the cost in this option is relatively lower than those in Option 1 individual certification (Will, 2010). In response to this new standard, three farmer groups consisting of 50 farmers certified with GLOBALGAP Option 2 in 2008,

and thirteen farmers groups with 200 farmers each were certified in 2010 (Chuenprayoth, 2011).

National GAP of Thailand (Q-GAP)

National GAP or Q-GAP standard has been developed by the Thai government as a part of the national strategy for food safety and has been implemented since 2004. Q-GAP standard is a public voluntary standard aiming to improve quality and safety of agricultural products with respect to the environment and ecology. In addition, the standard's objective is to increase consumer confidence in the domestic market and to enhance competitiveness in the international marketplace (ACFS, 2011b).

The Ministry of Agriculture and Cooperatives, responsible for the food safety policy, assigned the National Bureau of Agricultural Commodity and Food Standard (ACFS) to act as a national accreditation body and the DOA to act as a national certification body. Q-GAP training and advisory services for producers/producer groups are offered by the Department of Agricultural Extension (DOAE). The scheme is voluntary, managed by the government (the legal owner is ACFS), and free of charge.

The standard consists of eight key points including requirements and farm production inspection practises. The control points are: (1) water source; (2) cultivation site; (3) use of agricultural hazardous substances; (4) product storage and on-site transportation; (5) data

records; (6) production of disease and pest-free products; (7) management of quality agricultural production; and (8) harvesting and post-harvest handling.

The implementation process is as follows: producers interested in implementing Q-GAP submit the application form and relevant documents to the Office of Agricultural Research and Development (OARD) located in the local area; then, approved producers participate in the both a theoretical and practical training course on Q-GAP provided by DOAE; afterwards, producers conduct farm cultivation according to Q-GAP requirements under the supervision of DOA; the farm inspection is conducted by OARD according to the specific crop protocols; subsequently, the producers are informed of the results of the inspection and within a given number of days they have to perform correction actions (if needed); the GAP inspection form is submitted to the OARD board to review and presented to the sub-committee on GAP certification; this sub-committee compiles and submits the information to the Committee on Food Safety Management, which then issues the GAP certificate; finally, producers who obtain GAP certification are permitted to label their products with GAP logo: the 'Q' mark (Figure 2). In addition, the certified farms will be audited at least one more time by the government agencies after obtaining the certification.

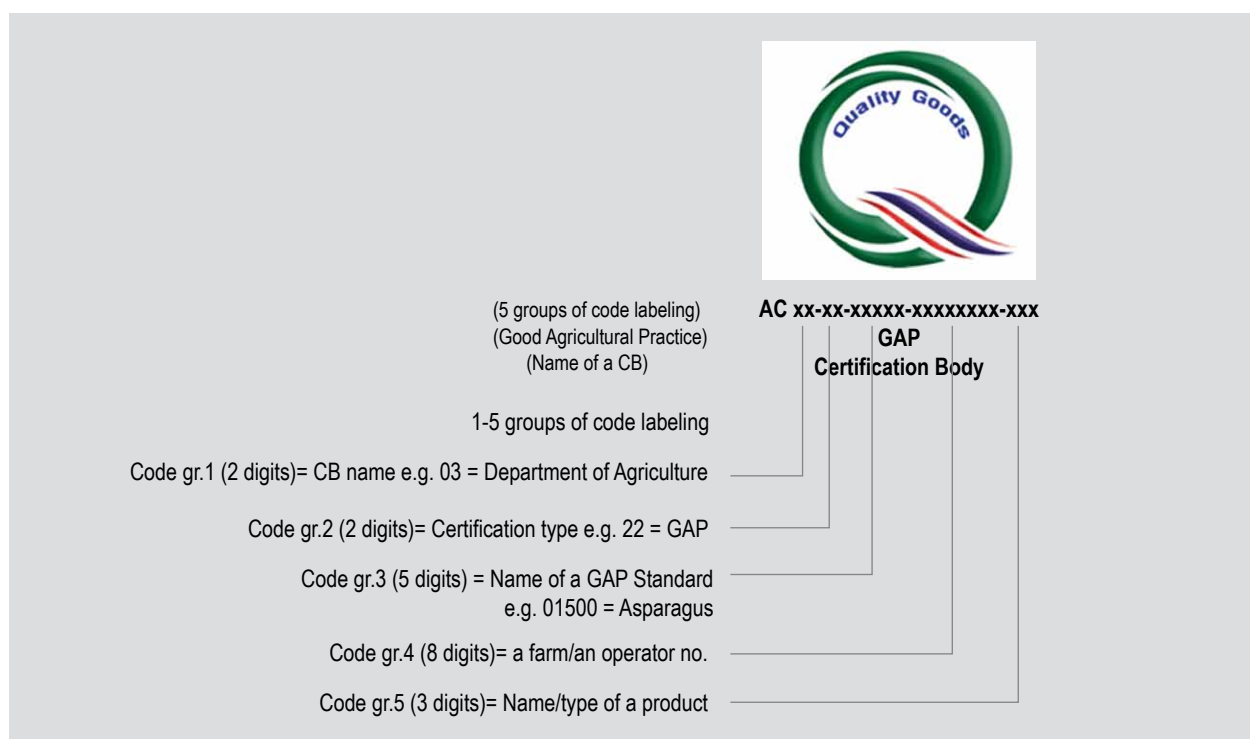


Figure 2. National good agricultural practices logo (Q-GAP) with code labelling (Wannamolee, 2008)

The standard does not include the regulations for traceability and segregation of certified products. Consequently, difficulties to track products and to recall and/or withdraw product in case of non-conformity may arise. The government agencies attempt to resolve this problem by establishing criteria for Q mark usage. According to TACFS 9005-2548 (ACFS, 2005; criteria for the use of certification marks Q and Q premium on agricultural and food commodities issued by ACFS), section 4, in order to use Q mark, the primary production processes at farm level has to be in accordance with the requirements of national GAP standards and be certified by the CB; the production process and post-harvest activities (e.g. pack house facilities) has to conform to GMP or HACCP and must be certified by the CB; the operators must observe procedures for tracing products and complying with traceability requirement; and products using Q mark will be tested for quality and safety. Nevertheless, the traceability of these products throughout the supply chain was still considered ineffective (UNCTAD, 2005).

Currently, DOA has provided crop protocols and certifications for 316 crops. As of the 2 January 2013, DOA has registered 237,046 farms (4.03% of total farms in Thailand) for GAP, as of 231,792 farms have been GAP certified with a combined area of 1,900,904 rai or 3,041.45 km² (1.25% of total agricultural area in Thailand). The majority of certifications for fruit pertains to longan (41,864 farms; 249,962 rai; 399.94 km²), long kong (7,363 farms; 33,279 rai; 53.25 km²) and mangoesteen (7,149 farms; 47,740 rai; 76.38 km²), and for vegetables includes chili (2,046 farms; 4,318 rai; 6.91 km²), asparagus (1,218 farms; 2,993 rai; 4.79 km²) and lemon (779 farms; 4,436 rai; 7.10 km²) (<http://gap.doa.go.th/gap/Default.aspx>).

Table 2 compares number of GAP farms, Q-GAP certification and area among main export products in 2005, 2008 and 2012. It seems that the amount of farm land area

of Q-GAP in Thailand is decreasing both in general figures and in specific export products. This may be a consequence of producers, especially export producers, switching to GLOBALGAP and ThaiGAP standards. However, to the best of our knowledge, there is no clear evidence of these changes on the statistical reports of GLOBALGAP and ThaiGAP area in Thailand.

ThaiGAP

ThaiGAP is a Thai private sector body that set up the Thai voluntary private standard for good agricultural practices covering all processes from seeding to handling. It was established in 2007 with the aim of building confidence among business partners and consumers that the products are in compliance with international standards as well as environmental sustainability criteria. It has been developed through the collaboration of various governmental and private agencies (www.thaigap.org). The owner of ThaiGAP is the Board of Trade of Thailand (BOTT). ThaiGAP Institute is the main organisation and it consists of (1) National Food Institute serving as the ThaiGAP secretariat, responsible for finance, administration, and certification scheme; and (2) the Kasetsart University responsible for technical advice and capacity building for ThaiGAP members. Other components of ThaiGAP Institute are Independent National Standard Committee recognised by BOTT, members (producers, exporters, retailers) and registered certification bodies (CMi, SGS, and TÜV Nord CERT).

The certification is divided into two levels: level 1 is for export products; and level 2 is for domestic market; both levels have 2 options (individual and group). ThaiGAP version 2.0 level 1 targets international market because it has already completed benchmarking procedures for approved modified checklist (the checklists of ThaiGAP are recognised by GLOBALGAP as fully conforming with

Table 2. Comparison of Q-GAP farms, Q-GAP certified farm and area among main exports products in 2005, 2008, 2012. Statistics of 2012 are from GAP DOA online database (<http://gap.doa.go.th/gap/Default.aspx>); statistics of 2008 are from Wannamolee (2008); statistics of 2005 are from UNCTAD (2005).

Crops	No. of Q-GAP farms			No. of Q-GAP certified farms			Q-GAP area (km ²)		
	2005	2008	2012	2005	2008	2012	2005	2008	2012
Longan	n.a. ¹	n.a.	70,134	n.a.	59,247	37,986	n.a.	581.78	522.84
Mango	7,762	n.a.	9,361	6,248	7,469	6,275	n.a.	164.65	152.77
Baby corn	1,903	n.a.	1,656	1,551	1,382	716	n.a.	7.36	6.41
Asparagus	3,803	n.a.	2,969	3,416	1,608	1,345	n.a.	5.33	4.56
Others	n.a.	n.a.	165,336	n.a.	100,180	94,241	n.a.	1,147.09	1,141.04
Total	n.a.	363,946	249,456	n.a.	169,886	140,563	n.a.	1,906.21	1,827.62

¹ n.a. = no data available. Q-GAP = the national good agricultural practices of Thailand.

its CPCCs and general rules as scheme management rules for certification) and has been acknowledged as a GLOBALGAP integrated farm assurance standard version 4 for fruit and vegetables equivalent in March 2013 (GLOBALGAP, 2013b), indicating producers and exporters who obtain ThaiGAP Level 1 certification can enter into the markets requiring GLOBALGAP certification. ThaiGAP Level 2 targets retailers in the domestic market, in order to improve the food safety standard in the domestic market starting from high-end market; hence, it was designed to be an intermediate standard between GLOBALGAP and Q-GAP. Currently ThaiGAP level 2 has been applied as a pilot test with 50 farmers who are suppliers linked with internationally owned retail chains operating in Thailand such as Top, Siam Makro, and Big C (Wattanavaekin, 2011). As of 2012, ThaiGAP level 2 will be implemented with local retailers (Chuenprayoth, 2011). In September 2013, the Thai Chamber of Commerce and Board of Trade of Thailand and Thai Retailers Association together with five large retail chains (Siam Makro, Central Food Retail, CP All, Tesco Lotus, and Big C) signed the agreement to support and distribute food products with ThaiGAP certifications (ThaiPost, 2013).

Implementation of the certification process starts from when the application for membership to ThaiGAP Institute is made, then producers or firms apply for certification and sign a contract with ThaiGAP CB (third party CB) on mutual agreements. Subsequently, farms are assessed by CB at least 2 times, if the farms passes the auditing process (100% major must; 95% minor must; recommendation), the ThaiGAP certification will be issued by CB. Subsequent and unannounced inspections will be conducted as well. The certification is valid for 1 year (ThaiGAP, 2010).

Comparison of Q-GAP, ThaiGAP, and GLOBALGAP standards

Comparison of the main features of the GAP standards

We compared the main features of the GAP standards adopted in Thailand regarding to general issues and GAPs concepts (Table 3 and Table 4). Currently, products with Q-GAP certification have been accepted only in domestic and regional markets (e.g. China, Singapore, Taiwan, Malaysia, etc.). The system and certification mark is not internationally recognised (Wipplinger *et al.*, 2006). The main reason is that farm practices, standards and enforcement do not meet the higher level demanded by the international standard, and the tracking and tracing system is considered ineffective. In some regional markets, like Japan, customers are asking for additional samples and inspection for chemical residues and biological contamination. While in the EU and the USA markets, more stringent standards such as GLOBALGAP are required. Furthermore, the entire GAP certification process is all carried out by the government, from setting the standards and serving as the national regulatory body to providing advisory service, carrying out farm inspection and finally issuing the certification. Since in the business environment usually much more confidence is put in quality assurance systems managed by private organisations, the credibility of the standard and 'Q' label is still low (UNCTAD, 2005). The Thai government is planning to out-source the inspection and auditing job to third-party private firms in order to gain higher acceptance and credibility in the international market; however, this process has not yet been completed (Sardsud, 2007). Currently, there is no private agent (national or international) acting as a certification body.

ThaiGAP is currently adopted only by suppliers associated with exporters; however, it aims to extend its coverage to

Table 3. Comparison of the main features of Q-GAP, ThaiGAP, and GLOBALGAP certification: general issues.

Features	Q-GAP	ThaiGAP	GLOBALGAP
Ownerships	government sector (ACFS)	private sector (the Board of Trade of Thailand)	private sector (GLOBALGAP)
Duration of certification	2 years for annual crops and 3 years for perennial plants	12 months	12 months
Classifications	there is no level	- level 1: export market; - level 2: domestic market; - both levels have 2 options: individual and group certification	- option 1 and 3: individual certification; - option 2 and 4: group certification
External audit and inspection responsibility	government officers	third party certifiers (accredited private firms)	third party certifiers (accredited private firms)
Cost	free of charge	high service charge	high service charge
Recognition by the market	domestic and regional markets	International; equivalence with GLOBALGAP but still known only among trade partners of Thai companies (e.g. European partners)	international markets

Table 4. Comparison of the main features of Q-GAP, ThaiGAP, and GLOBALGAP certification: good agricultural practices (GAP) issues.

Features	Q-GAP	ThaiGAP	GLOBALGAP
Food safety	emphasis mainly on chemical contamination and residues	concern on the 3 main contamination hazards in crop production: chemical; biological; and physical contamination	concern on the 3 main contamination hazards in crop production: chemical; biological; and physical contamination; strict regulations about pesticide storage and pesticide residue limits
Traceability	no clear traceability system required	it requires producers to establish a complete control and monitoring system so the system can be tracked and traced effectively	it requires producers to establish a complete control and monitoring system so the system can be tracked and traced effectively
Worker welfare and personal hygiene and sanitary facilities	no control point and compliance criteria (CPCC) concerns to this issue; depends on labour and public health laws	CPCC covers this issue	CPCC covers this issue
Environmental issues	no CPCC concerns to this issue. Depends on environmental laws	CPCC covers this issue	CPCC covers this issue

Thai food retailers and high-end market suppliers in the domestic markets through ThaiGAP level 2 (Chuenprayoth, 2011). ThaiGAP is a new standard thus time to build up credibility and reputation in the domestic and international market is required. However, its main advantage is that this standard is led by a private operator and auditing is performed by third party firms, conferring credibility to the standard. On the other hand, Thai suppliers have better access and obtain advice and feedback in Thai language.

At present, Q-GAP standard focuses mainly on chemical contamination and residues, therefore the extension of coverage to biological and physical contamination are required to make the standard more in line with GAP principle. The worker welfare and environmental issues are also missing from Q-GAP standard. Documentation and record keeping are also mentioned by several studies, which highlight that Q-GAP does not emphasise these issues enough, thus possibly resulting in inadequate tracking system (e.g. UNCTAD, 2005; Wannamolee, 2008). ThaiGAP, which is considered a middle standard between Q-GAP and GLOBALGAP, covered all the main principles of GAPs; nevertheless, the traceability system is in its initial stages and required further development.

Perceptual map of the GAP standards

In order to draw a perceptual map of the GAP standards described above, overall similarity scores to 21 unique pairs of the 7 GAP standards were assigned and analysed by using the mdsmat model in the Stata 11.0 software package (Hair *et al.*, 2010). The appropriate dimensionality

was chosen by looking at the average measures of fit, the improvement of Kruskal's stress (Kruskal and Wish, 1978) and R squared parameters as the number of dimensions increases. A two-dimensional solution was selected as a solution most appropriate and easy to interpret. It explained 82% of the variance (Kruskal's stress = 0.1787), while a three-dimensional solution provided only a small improvement in the overall fit.

Figure 3 presents the location of the GAP standards in the two-dimensional space. Points mapped close together are similar while points mapped further apart are dissimilar. Visual examination of the location of the GAP standards reveals four distinct clusters: (1) to the top right, GLOBALGAP level 1, GLOBALGAP level 2; (2) to the bottom right, ThaiGAP level 1, option 1 and option 2; (3) to the top left, Q-GAP; and (4) to the bottom left, ThaiGAP level 2, option 1 and 2. It is evident that the position of the objects reflects mainly the differences among the standard schemes, while individual differences of standards that belong to the same standard schemes are in our perception less important.

In order to interpret the stimulus space, the authors examined the relevant attributes that could be considered to underlie these two dimensions and agreed that 'trustworthiness' and 'usefulness in the business' (recognition in the market) may be the principal attributes. The horizontal dimension (dimension 1) may be interpreted as 'trustworthiness', placing on the right the most trustworthy schemes. The vertical dimension (dimension 2) is interpreted as 'usefulness in the business',

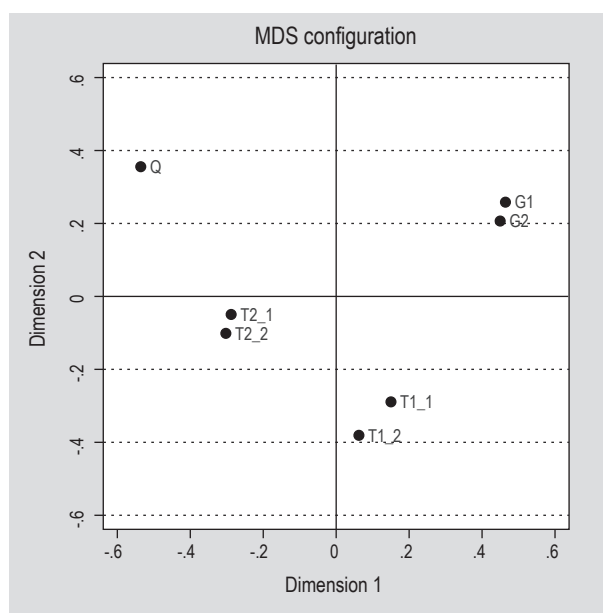


Figure 3. Perceptual map of the good agricultural practices (GAP) standards on 2 dimensions. The map is based on the similarity judgements given by the authors. G1 = GLOBALGAP option 1, G2 = GLOBALGAP option 2, T1_1 = ThaiGAP level 1, option 1, T1_2 = ThaiGAP level 1, option 2, T2_1 = ThaiGAP level 2, option 1, T2_2 = ThaiGAP level 2, option 2, Q1 = Q-GAP level 1, Q2 = Q-GAP level 2, Q3 = Q-GAP level 3.

in which a position on the top indicates a more useful business scheme because of recognition by customers or consumers (the latter in the case of Q-GAP). It should be noted that standards on the left are characterised by a more international approach, whereas standards on the right are more domestic.

Regarding trustworthiness, the GLOBALGAP standard is deemed the most trustworthy, followed by ThaiGAP level 1, and ThaiGAP level 2, respectively, the different options do not determine perceived differences; on the contrary, Q-GAP appears to be perceived as less trustworthy. Considering business usefulness, Q-GAP and GLOBALGAP appear to confer a higher competitive business advantage for companies than ThaiGAP, as they are already well established in the Thai and international markets, respectively, and have been widely recognised by the customers. In fact, Q-GAP is communicated to consumers using the Q mark label on quality products in the Thai domestic market and GLOBALGAP is the *de facto* standard for entry into the international market, and is considered almost as a ticket-to-ride for EU importers. Regarding the ThaiGAP standards, ThaiGAP level 2 has been just recently implemented in the domestic market resulting in a low awareness of the standard; however, since it will be communicated among domestic consumers, it is perceived as more competitive than ThaiGAP level 1 in the Thai market. At the same time, ThaiGAP level 1 may

be less attractive to an export company because it is too similar to GLOBALGAP, thus a company may preferentially select GLOBALGAP instead as it is more accepted in the international markets. The distances between different options in GLOBALGAP and ThaiGAP standards may depend upon lower trust in group's implementation and control than the individual ones.

It must be emphasised that this perceptual map represents the subjective authors' perceptions only of the different GAP standards.

Challenges in the adoption of food safety assurance system in Thai fresh produce production

Although GAP standards adoption clearly confers numerous benefits (for instance, promotion of food safety and sustainable agriculture, enhancing competitiveness of Thai products in the international market, etc.), several challenges exist constrain the implementation of GAP in Thailand. These challenges may be grouped into production challenges, distribution and marketing challenges, and certification, enforcement and labelling challenges. The following sections discusses these aspects in greater detail.

Production challenges

The low market incentive to adopt GAP is the main challenge in the agricultural production tier of the food supply chain. GAP certified products normally do not obtain a premium price, while certification requires farmers to make an initial investment and to regularly spend money and time to learn, implement and manage the system. Therefore, there are few producers in implementing GAP and most are suppliers of exporters or other large retailers for whom GAP is a prerequisite for doing business (Sardsud, 2007). GAP implementation and especially record keeping and certification will increase production costs, while in many cases there is no expectation that product price could increase accordingly, except for companies that are able to access export markets (Canavari and Spadoni, 2004; Gawron and Theuvsen, 2006; Jahn *et al.*, 2005; Schulze *et al.*, 2008; Soon, 2012). The adoption of any FSAS and quality management system (QMS); however, does usually improve the competitiveness of companies because of its impact on internal organisation and management procedures. This benefit may not be perceived immediately by the companies/farms that consider a FSAS and QMS implementation (Lombardi *et al.*, 2011). Hence, many producers do not see the advantage of GAP adoption. This problem is connected to the lack of awareness about safety, environmental and social impacts of agricultural practices; as a result there is a resistance to changing already established farming practices. In addition, pesticides remain a cheap solution for farmers as subsidies are provided for chemical products and high labour costs (Sardsud, 2007). This situation is

usually common in developing countries where domestic markets have low demand on high quality products or alternative export markets do not require strict regulations, hence small producers are less inclined to comply with international stringent standards (i.e. GLOBALGAP) as certifications come with a high cost burden yet no price incentives (Ouma, 2010).

The lack of knowledge on GAP principles and requirements is another principal barrier of GAP adoption in Thailand. This is based on insufficient information about GAP programme and inadequate access to information and support services from the public and private sectors (FAO, 2007). Low levels of education and knowledge of Thai producers also hinders the implementation of GAP because in many cases they are not able to understand the main principles of quality management, which are the underlying basis for any FSAS and QMS. Without an understanding of these principles and assumptions (especially the continuous improvement principle), these systems can be perceived by producers just as an additional cost and a system that just produces additional paperwork (Sardsud, 2007; UNCTAD, 2005; Wannamolee, 2008). These issues may be overcome by appropriate training activities focusing on GAP's principles and practice issues and by finding and implementing other effective tools to keep records, instead of requiring piles of documents.

Sriboonchitta *et al.* (2008) studied the factors affecting GAP adoption in pineapple production in Thailand and demonstrated that factors associated with GAP adoption include the average farm price, having contract with buying companies, average yield, being a progressive farmer, food safety and food standard requirements of the importing countries and the farmer's own environmental concern. In contrast, age is associated with a reduced adoption. This finding is congruent with the study of Kersting and Wollni (2012) that demonstrated that positive factors affecting GLOBALGAP adoption of small-scale fruit and vegetable farmers in Thailand are household and farm characteristics, the number of agricultural training attended, support by downstream actors (i.e. exporters), education, availability of family labour, household wealth, farm size and the intensity of irrigation usage, while age of the head of the household has a negative effect on standard adoption. In addition, they found that support by exporters to implement GLOBALGAP is crucial. Together with household characteristics and training attendance, the only market condition considered as a key factor is the presence of relations with exporters.

There is evidence supporting the theory that export markets (particularly the EU market) and external pressure are dominant factors of FSAS adoption for farmers. Kleinwechter and Grethe (2006) found that association with exporters is the key factor in EurepGAP adoption among

Mango producers in Peru, while the access to information and lack of knowledge appeared to be important constraints in the correct implementation of the standard. Souza Monteiro and Caswell (2009) found that factors affecting the pear industry farm-level adoption of EurepGAP traceability in Portugal are the export market (the UK), membership in producer organisations, farm productivity, specific product labels (Protected Denomination of Origin-PDO) and farmers' age. Zhou *et al.* (2011) found that firm's characteristics, expected premium, export market, brand name, e-commerce, training frequency and traceability were affecting the adoption of food safety/quality standards in the Chinese vegetable processing sector. Jahn and Spiller (2007) investigated the adoption of the 'Qualität und Sicherheit' system among German livestock farmers and found that the main factors affecting the system adoption are customer requirement and external pressure (i.e. label's reliability, fairness of the introduction and pressure of participation). Hence, in the initial stage of the standard introduction, external markets and customer demands will have a high influence on GAP development in Thailand. As a matter of fact, currently Thai producers mostly implement GAP under contract farming and frequently rely on a few exporters and the external markets. This may affect the sustainability of GAP in Thailand in the long-run.

Several stakeholders have attempted to establish GAP with group certification in Thailand. However, this attempt is still in the initial stage and it will take time to educate and provide information to farmer groups. Furthermore, insufficient organisation of small growers in producer associations imposes a significant challenge to this type of certification (Will, 2010).

Distribution and marketing challenges

At present, the majority of collectors, brokers, wholesalers and sellers in wet market are not concerned about GAP or other food safety certification of fresh produce; they are concerned only about mandatory regulations according to national food safety laws (Buurma and Saranark, 2006). The main reason is the perception that the certification requirement will restrict transaction freedoms with producers and may increase costs, while not receiving a premium price for their product. Furthermore, the majority of Thai consumers (except in urban areas) use product's quality and price as main factors in their food choice decision, rather than food safety (Lippe *et al.*, 2010), thus resulting in low supply from the supplier side. This may be attributed to a consumer perception that 'safe' food is baseline characteristic, which is expected to be guaranteed from all products available in the market (e.g. Canavari *et al.*, 2010a,b; Ritson and Mai, 1998; Rozan *et al.*, 2004). Furthermore, the safety of food products is a credence attribute thus it cannot be assessed; hence, quality

indicators are used in purchasing decisions instead (De Jonge *et al.*, 2004; Van Rijswijk and Frewer, 2008).

However, some firms may implement strict food safety regulations and standards to promote their products as having a higher quality to gain advantages in the competitive business environment (Ragona *et al.*, 2011). For instance, several supermarket chains in Thailand (e.g. TOPS, the Mall, Tesco-Lotus, Carrefour, MAKRO) are gradually introducing GAP to the domestic supply chain in order to improve food safety level and gain a reputation as high-quality supermarket chain (Buurma and Saranark, 2006). Arpanutud *et al.* (2009) mentioned that Thai distributors and food-manufacturing firms are interested in adopting FSAS such as GAP, GMP, and HACCP only when it is perceived to confer a competitive advantage, reduce transaction cost, improve quality, increase sales, gain reputation and show that the top management commits to food safety. In addition, the more food safety information the firm receives, the more likely that the firm will adopt FSAS. It was also demonstrated that Thai firms considered government agencies as one of their main information sources. Hence, food safety certification could be used as a tool to create brand reputation in the high end market (Lippe, 2010). Lippe (2010) concludes that Thai consumers in urban areas are willing to pay higher prices for safety labelled fresh fruit and vegetables, thus, creating a reward for adopting GAP also in the domestic market. The study suggests that public intervention is needed to ensure reliability and credibility of certification and labelling system.

Nevertheless, Thai consumers still consider food safety control as a task of government and rely more on government labels such as 'Q mark' and 'food safety' (Lippe, 2010). This highlights the importance of the role played by government agencies in disseminating knowledge and information to suppliers, firms and consumers in order to improve the food safety level in the domestic market.

Certification, enforcement and labelling challenges

GAP standards managed by private sectors such as GLOBALGAP and ThaiGAP are more credible in certification, enforcement and labelling issues, as they have clear regulations and are monitored and controlled by third party certification bodies. Likewise, these standards are usually pre-requisites for entry into high-end markets and are required by business partners. Therefore, implementation of high quality standards is an imperative for suppliers in this side of the supply chain (Fulponi, 2006). However, these standards are also particularly common for producers associated with exporters only, because of high certification cost and complicated regulation. On the other side, Q-GAP managed by the government agencies faces more challenges in enforcing regulations (Sardsud,

2007). Q-GAP was established by the government and the stakeholders play only a minor role in its implementation, therefore communication between and cooperation from all actors along the whole supply chain can be challenging (Oates, 2006; Sardsud, 2007). Thus, difficulties in inspection, control and tracking certified products along the chain are generated as some actors do not participate in or are concerned about the programme. Consequently, the certified products lose the ability to convey the value (as certified GAP products) to the end-consumers.

The presence of several standards may represent an advantage as producers have several choices and have the possibility to select an option most suitable for them. However, the lack of harmonisation of GAP standards implemented in Thailand creates confusion among producers and suppliers because they have to implement several standards according to the partners' requirements for domestic, regional and international markets. Therefore, benchmarking of GAP standards in Thailand with international recognised standards (e.g. GLOBALGAP) and harmonising with other coexisting GAPs may mitigate the confusion among stakeholders (Sardsud, 2007).

4. Conclusions

Food safety is a national issue and Thai government and stakeholders are acutely aware of the issue. FSAS is one of the tools utilised to control and monitor food safety along Thai food supply chain. GAP is employed as a scheme to guarantee food safety, quality and sustainable agriculture in crop production. Currently there are three main voluntary GAP standards adopted in Thailand: national GAP or Q-GAP, ThaiGAP and GLOBALGAP. While GLOBALGAP is a private internationally recognised standard, Q-GAP and ThaiGAP are local standards, which have been developed by the government and private sectors, respectively.

The perceptual map we developed reveals that GLOBALGAP is the benchmark for other GAP standards, both on trustworthiness and business usefulness aspects. While ThaiGAP is perceived as possessing a higher trustworthiness than Q-GAP, Q-GAP confers a higher business advantages because it has been recognised on the domestic and regional market. In order to improve trustworthiness, Q-GAP standard regulation should be strictly enforced, the inspection should be done by third parties and an efficient traceability system need to be implemented. Whereas, promotion and marketing activity should be applied for ThaiGAP level 2 in order to improve its recognition in the market.

Considering the current situation of GAP implementation in the Thai domestic market, the implementation is considerably weak. Apart from the voluntary standards discussed so far, there is not a comprehensive mandatory

standard according to Thai law. Currently, the Thai domestic market does not provide enough market incentives for adoption (e.g. premium price or increase the possibility to entry the market or enhance the competitiveness of the supplier). Hence, most of producers do not perceive the advantages of adopting GAP, as expected market benefits derived from GAP or FSAS implementation are not apparent (Lombardi *et al.*, 2011). However, this trend seems to be slowly changing as retailers have recently started to impose GAP adoption on their suppliers to achieve higher food safety level and gain a favourable reputation as safe food providers. This has become particularly relevant in the Thai context following a series of food scares in the country such as avian influenza (bird flu) in 2004 and the recurring, and scandals of high chemical residues on some fresh produce (e.g. Chinese kale and cabbage). Therefore, consumers are increasingly searching for food safety guarantees in the form of a certification or trusted brands. There is also evidence that Thai consumers have increased awareness on food safety and some of them are willing to pay a higher price for safe food, especially in the urban area (e.g. Lippe, 2010; Takeuchi and Boonprab, 2006). These situations indicate that in the future, more stringent GAP schemes may be applied in the domestic market as consumers pay more attention to food safety issue.

However, further research on practitioners' and stakeholders' perceptions of standards should be conducted in order to obtain more information regarding these standards e.g. perceived trustworthiness and business usefulness from the business point of view. This could be conducted by building upon the results of this review and using investigation methods based on primary data. For instance, the MDS technique we used to subjectively describe our point of view of the standards could be further employed in the analysis of the perceptions of practitioners and to elucidate the (dis)advantages of each standards (e.g. Canavari *et al.*, 2007). Further research on consumers' perception and willingness to pay for certified products could be conducted in order to obtain information from the demand side.

In conclusion, the problem for implementing FSAS and GAP in Thailand is rooted in the lack of knowledge and understanding of principles, and the perception of advantages (especially the internal ones) that FSAS adoption and implementation may confer among stakeholders. Therefore, a possible solution could include creating awareness about food safety and GAP among stakeholders, including the domestic consumer sector, and involving players on the system. In this context, government agencies must play an important role in disseminating knowledge and information. In our opinion, currently the most promising standard in terms of wide adoption is the Thai national Q-GAP standard. Although Q-GAP is perceived as weakly enforced and with low credibility

(because of the whole process implementation is carried out by the government), Thai consumers and domestic markets rely upon it because it is the only way to access mass producers and markets. Therefore, the next step is to improve Q-GAP to confer a higher credibility. This could be achieved by several means, such as offering more business incentives among domestic distribution channels, outsourcing auditing tasks to third party private firms, strictly enforcing the regulations, improving training, and creating documentation and record-keeping tasks more suitable for Thai producers. The adoption of Q-GAP could be a first step for many producers to perceive not only the cost but also the benefits of GAP standards. It may represent an entry level from which some of them may decide to upgrade to more demanding standards. Finally, GAP standards for domestic market may not need to be the same as international ones, but rather should be adapted to the Thai agricultural context, while still retaining important elements that ensure a high level of food safety, quality and that promote sustainable agriculture.

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