Trop. Agr. Develop. 60(1): 1 − 9, 2016

Do GAP Farmers do Better than Non-GAP Farmers?: Pesticide Management Practices of Horticultural Farmers in Damnoen Saduak, Thailand

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Abstract In order to provide better and safer agricultural food products, the Thai government has introduced a public standard of good agricultural practices (GAP) which has been implemented since 2004. Using data obtained from interviews with farmers applying intensive horticultural systems in Damnoen Saduak District (Ratchaburi Province) we determined whether those who followed the GAP program could gain access to foreign markets to sell their produce and whether their practices were better in terms of improving food security and worker safety through adequate synthetic pesticide use compared to non-GAP farmers. The results showed that the GAP program has been beneficial for the farmers, by focusing its efforts on certification which is a necessary requirement for export access. However, pesticide management practices did not differ between GAP and non-GAP farmers. We argue that inadequate implementation of the standard in the region is due to a lack of sufficient governmental resources necessary to train farmers and to control on-farm activities that may lead to a decrease in synthetic pesticide use.
Key words: Farmers, Good agricultural practices, Synthetic pesticides

Introduction

For at least the last six decades, the world's use of pesticides in agriculture has been increasing (Matson *et al.*, 1997; Kogan and Bajwa, 1999; FAO, 2014) and with it, the risks at which people and the environment are exposed, especially if overused or misused (Pimentel *et al.*, 1992; Matson *et al.*, 1997), have also been increasing.

Thailand and other Southeast Asian countries which export fresh fruits and vegetables are experiencing this situation (Thapinta and Hudak, 2000; Rerkasem, 2005; Athisook *et al.*, 2007; Praneetvatakul *et al.*, 2013; FAO, 2014) and in order to counteract the potential negative aspects of this trend, alternative crop production systems focused on safety and sustainability are being implemented (Kogan and Bajwa, 1999; Srithamma *et al.*, 2005; Ehler, 2006).

A widely employed standard in Thailand involves a code of conduct called "Good Agricultural Practices" (GAP), which was designed to obtain good quality produce, safe and suitable for consumption by taking environment, health, safety and welfare of workers into account (NBACFS, 2009).

Among the various approaches of GAP (FAO, 2007), the present study focused on the public standard promoted by the government to help smallholders gain access to mainstream markets, especially foreign ones (Amekawa, 2013). This GAP must not be confused with the "GlobalGAP" which is private and is becoming the leading standard worldwide (Nadvi and Waltring, 2004; Humphrey, 2006; Mausch *et al.*, 2006; Henson and Humphrey, 2010; Tallontire *et al.*, 2011).

The GAP standard (also referred to as Q-GAP, where the letter Q stands for quality) is based on eight farm-related elements which must have been taken care of, including water sources, plantation area, pesticide application, quality management in pre-harvest activities, quality of harvest and post-harvest handling methods, holding of produce (moving and storage of produce within the plantation), personal hygiene, and data recording and traceability (NBACFS, 2009). Of all these, emphasis was placed on the third element "pesticide application" in order to produce safe food through the control of pesticide residues on the produce (Sardsud, 2007; Wannamolee, 2008; Schreinemachers *et al.*, 2012; Amekawa, 2013).

The Ministry of Agriculture and Cooperatives (MoAC), Thailand, through its Department of Agriculture (DoA) is the government's organization responsible for implementing the GAP program. It has mainly focused on reducing the amounts of pesticides used and has designed the standard so that the agricultural practices incorporate the principles of Integrated Pest Man-

Communicated by R. Miyaura
Received Sept. 18, 2014
Accepted Jan. 6, 2015
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agement (IPM) (NBACFS, 2009). The main functions of the DoA consist of processing the GAP applications, providing certification after farmers pass the necessary inspection, and subsequently monitoring and auditing farm practices for adequate implementation of the GAP standard (Wannamolee, 2008).

The DoA is also involved in the surveillance and evaluation of the pesticides that exert a severe adverse impact on human health or the environment and it can take action to ban or strongly restrict their use. This applies to methomyl, dicrotophos, aldicarb, blasticidin-S, carbofuran, ethoprophos, formetanate, methidathion, oxamyl, and ethyl p-nitrophenyl thionobenzenephosphonate (EPN) (Panuwet *et al.*, 2012). In the case of Cypermethrin and Abamectin, which are linked to the outbreaks of pests in the country and elsewhere in Asia, the DoA has developed campaigns to avoid their misuse (IRRI, 2011).

The organization responsible for conveying the pertinent pesticide-related information to the farmers is another body of the MoAC, the Department of Agricultural Extension (DoAE), which provides GAP training and advisory services aimed at the reduction of synthetic pesticide use, and incorporation of alternative pest management techniques. The DoAE, being the government's agricultural extension agent, also provides training about these topics to non-GAP farmers (Sardsud, 2007; Wannamolee, 2008; Amekawa, 2013).

In the present study, the practices of horticultural farmers were compared to determine whether the GAP program had allowed them better opportunities to gain access to international markets and whether the practices associated with certification were preferable in terms of improving food security and worker safety through adequate synthetic pesticide use. We expected that farmers under the GAP program, would use less hazardous pesticides, handle them in a safer way and spray their crops less often (avoid preventive spraying). We assumed that these aspects would be related to the GAP training and auditing received from the MoAC.

Methods

Description of the study area

Damnoen Saduak is a District in central Thailand in the Province of Ratchaburi. It is located in a lowland region, where fruits and vegetables are produced intensively through the use of a particular market-oriented agrarian system, in which horticultural fields are polderized in old tidal marsh located in the Mae Klong basin (western part of the Chao Phraya delta), standing in the fringes of more traditional rice-based systems. The horticultural plots consist of raised beds that are a part of a canal network providing drainage and irrigation systems throughout the year (Cheyroux, 2003). These beds alternate with ditches, in which water remains stagnant (Fig. 1). The crops planted on the beds are in most cases watered by the use of small boats which are led through the ditches and spray with a pump (Fig. 2) (Molle *et al.*, 1999).

Damnoen Saduak benefits from very specific socioeconomic conditions that make it a singular region, including a large canal network, proximity to Bangkok and an efficient chain of supply to various markets (Cheyroux *et al.*, 2006). Pesticide use in the region is widespread and frequent due to the intensive horticultural management (Molle *et al.*, 1999).

Data collection and analysis

Using structured questionnaires, we interviewed 86 randomly selected horticultural farmers in Damnoen

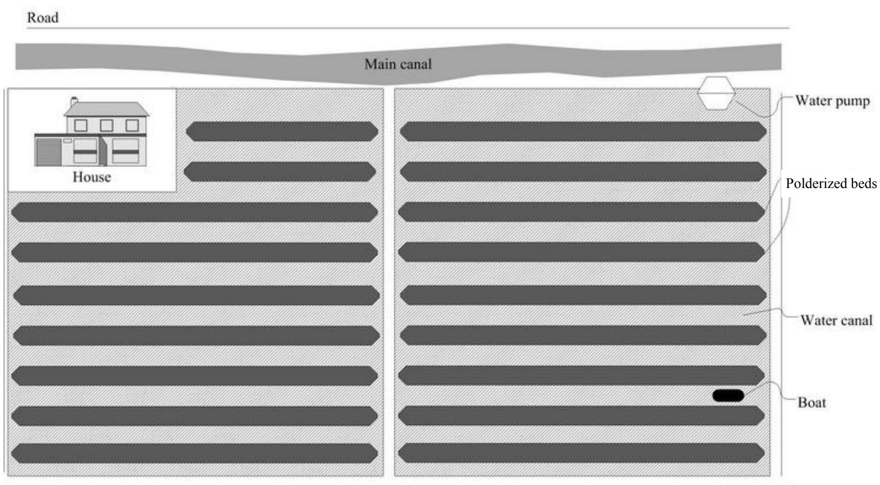

Fig. 1. Layout of a typical horticultural plot in Damnoen Saduak (not drawn to scale).

Fig. 2. Raised beds (approx. 2.1 m wide) of baby corn and asparagus cultivated in Damnoen Saduak separated by a water canal (approx. 2.2 m wide).

Saduak Sub-District which harbours around 1,700 farming families. The first interviews were conducted during the period from November 2012 to January 2013 to obtain general information about the types of crops grown, size of plots, farmers' experience, income, pesticides used, markets where produce is sold and certification with a GAP license.

During the period from March to April 2013, a second structured questionnaire was used to compare GAP and non-GAP farmer practices related to the use of agrochemicals. This time, the sample was increased to include 130 farmers. The interview covered questions about information collection, how the farmers handled insecticides and fertilizers, the precautions they took when they sprayed and the training received from the Department of Agricultural Extension (DoAE) of the Ministry of Agriculture and Cooperatives (MoAC), the office responsible for providing extension services, GAP training and technical advice to the farmers (Sardsud, 2007).

To learn more about the GAP program implementation and verify some of the data collected through the questionnaires, we interviewed several government officers from the DoAE and asked them about their duties and the limitations they faced. We also visited the DoAE office in Damnoen Saduak and were able to observe the farmers' GAP documentation archive.

Results

The farmers surveyed (n=86) in Damnoen Saduak District were smallholders (the area cultivated per farmer averaged 1.18±0.89ha), had an average of 23±11 years of experience in horticulture and their formal education ranged from 1 to 16 years of schooling.

Table 1 shows a list of 9 common fruits and vegetables that were cultivated in Damnoen Saduak District, ordered in two groups: A and B. Group A included the crops that were produced to be sold in international or domestic markets, while Group B included the crops that were produced to be sold exclusively in domestic markets.

Only the crops from Group A: asparagus (*Asparagus officinalis*), calamondin (*Citrofortunella* sp.), roseapple (*Syzygium* sp.) and coconut (*Cocos nucifera*) were cultivated by farmers that were certified under the GAP program. Conversely, crops from Group B: guava (*Psidium* sp.), pak kwantung (*Brassica* sp., one kind of Chinese cabbage), cucumber (*Cucumis sativus*), lettuce (*Lactuca sativa*) and yard long bean (*Vigna unguiculata*) were cultivated by non-GAP farmers only.

The collected pesticide information covered insecticides and fungicides, as they were reported to be used frequently by all the farmers. Herbicide information was not considered in this study since farmers reported that most weeding was performed manually and that its use was only occasional.

Table 1 also lists the most frequently reported synthetic insecticides used by the farmers sampled. All the pesticide formulations were registered by the Thai government in accordance with the Hazardous Substance Act (No. 3) B.E. 2551 (2008). The pesticides reported by at least 10% of the famers, in descending order were as follows: Methomyl, Abamectin, Cypermethrin and Chlorpyrifos. Methomyl is classified by the World Health Organization (WHO) as Class Ib "highly hazardous" pesticide. Abamectin (whose acute toxicity rating is derived from the United States Environmental Protection Agency, EPA classification), Cypermethrin and Chlorpyrifos are classified as "moderately hazardous" but are highly toxic to bees and hymenopterans as well as aquatic fauna, and can affect negatively a whole array of natural pest enemies (Heong and Schoenly, 1998; IRRI, 2011).

Similarly to the case of insecticides, Table 2 shows that the most frequently reported synthetic fungicides used by at least 10% of the farmers sampled were as follows: Carbendazim, Mancozeb, Copper compounds and Metalaxyl. These fungicides are less hazardous than the reported insecticides shown in Table 1. Copper compounds (copper hydroxide, copper oxychloride or copper sulfate) and Metalaxyl are classified as "moderately hazardous" by the WHO, and Carbendazim and Mancozeb are classified as "unlikely to present acute hazard in normal use".

We asked the farmers about the availability of infor-

Table 1. Percentage of sampled farmers who reported the use of insecticides according to crop, market and GAP certification.

Pesticide name	WHO Toxic Class.[1]	A (sold in foreign or domestic markets)								B (sold in domestic markets only)					Overall (n=86)
		Asparagus		Calamondin		Roseapple		Coconut		Guava	Pak kwantung	Cucumber	Lettuce	Yard long bean	
		GAP	Non-GAP	GAP	Non-GAP	GAP	Non-GAP	GAP	Non-GAP	Non-GAP	Non-GAP	Non-GAP	Non-GAP	Non-GAP	
		n[2] = 15	n = 10	n = 2	n = 4	n = 12	n = 10	n = 2	n = 1	n = 12	n = 9	n = 1	n = 4	n = 4	
Methomyl (lannate 90)	Ib	33	50	50	75	83	60	50		75	44		100	50	50
Abamectin	Not listed	60	50	100	100	58	40	50		33	44	100	50	25	44
Cypermethrin	II	33	40		25	25	40			25	22			100	26
Chlorpyrifos	II					8.3	10		100	75	22				14
Omethoate	Ib					8.3	20			8.3		100	25		6
Carbosulfan	II					25				8.3		100			5
Indoxacarb	II		10											100	5
Chlorantraniliprole (prevathon)	U	6.7						50			11				3
Malathion	III	6.7						50		8.3					3
Dimethoate,	II					8.3	10			8.3					3
Fipronil	II										33				3
Profenofos	II										33				3
Dicofol	II					8.3					11				2
Dicrotophos	Ib										11		25		2
Dichlorvos	Ib									17					2
Emamectin benzoate	Not Listed	6.7									11				2
Ethion	II					17									2
Fenobucarb (BMPC)	II					8.3	10								2
Quinalphos	II					8.3	10								2
Metrifonate or trichlorfon	II					8.3									1

[1] The World Health Organization classification of pesticides by hazard: Ib = Highly hazardous; II = Moderately hazardous; U = Unlikely to present acute hazard in normal use.
III = slightly hazardous.
[2] Number of farmers interviewed.

Table 2. Percentage of sampled farmers who reported the use of fungicides according to crop, market and GAP certification.

Pesticide name	WHO Toxic Class.[1]	A (sold in foreign or domestic markets)							B (sold in domestic markets only)				Overall (n=83)
		Asparagus		Calamondin		Roseapple		Guava	Pak kwantung	Cucumber	Lettuce	Yard long pea	
		n[2] = 15 GAP	n = 10 Non-GAP	n = 2 GAP	n = 4 Non-GAP	n = 12 GAP	n = 10 Non-GAP	n = 12 Non-GAP	n = 9 Non-GAP	n = 1 Non-GAP	n = 4 Non-GAP	n = 4 Non-GAP	
Carbendazim	U	73	50	50		66	40	58	22	100	50		41
Mancozeb	U	47	33			8.3							11
Copper compound[3]	II	27	20	50	25		10					25	10
Metalaxyl	II	6.7				8.3			33		25		6
Propineb (Antracol)	U	6.7						16	11			25	5
Chlorothalonil	U	6.7		50		8.3							3
Propiconazole+prochloraz	II	6.7	10							100			3
Benomyl	U					8.3							1
Difenoconazole	II	6.7											1
Propiconazole	II					8.3							1

[1] The World Health Organization classification of pesticides by hazard: II = Moderately hazardous and U = Unlikely to present acute hazard in normal use.
[2] Number of farmers interviewed.
[3] Either copper hydroxide, copper oxychloride or copper sulfate.

mation related to pesticide inputs used for the cultivation of their crops. The large majority (over 97%) of the farmers sampled answered that they did not practice daily data recording. This is noteworthy, especially in the case of the GAP farmers, since one of the standard's requirements expressly states the importance of data recording and traceability (NBACFS, 2009).

The absence of pesticide use records was later confirmed when we visited the DoAE office and were shown the GAP documentation archives of the farmers involved in the certification process. The documents consisted entirely of qualitative data of which most were compliance checklists about the seven other farm-related components required to be checked by the standard. We verified that each officer had assigned documentation related to at least two hundred farmers who applied for the GAP certification.

When interviewed, the officer responsible for the GAP program from the DoAE in Damnoen Saduak explained that this situation reflected a scarcity of trained professionals to process the GAP documentation and help farmers to be prepared for the initial inspection required to obtain the GAP license by training them about how to implement the farm-related components of the GAP standard. He pointed out that for the year 2013, nine of these professionals were working in the DoAE's office in Damnoen Saduak and that this number was insufficient.

Next, the second survey was carried out to compare practices related to pesticide application between GAP (n=50) and non-GAP farmers (n=80). The questions asked were based on the information provided by the guidance of the GAP standard (Section A.3, Appendix A of TAS 9001-2009) and conformed in a similar way to that used by Schreinemachers *et al.* (2012) for farmers in Chiang Mai province.

Table 3 shows the results of the comparison of pest management between GAP and non-GAP farmers. It appears that most of the farmers used synthetic pesticides only to control pests (72.0% for GAP farmers and 83.7% for non-GAP ones, with no statistically significant difference), while a small proportion of farmers complemented the use of synthetic pesticides with locally produced herb or medicinal plant-based pesticides. When asked for the reason why they used such non-synthetic pesticides, many farmers answered that it was mainly due to economic factors, since they could produce them cheaply at home or buy them at lower prices compared to synthetic pesticides.

In terms of pesticide handling, we did not find statistically significant differences between the two farmer groups, although two noteworthy aspects were observed. First, the majority of the farmers (92.0% of GAP farmers and 93.7% of non-GAP farmers) stated that they sprayed pesticides in a preventive way at regular intervals, regardless of the presence and abundance of pest populations. Secondly, they said that they determined the pesticide dosage and frequency of pesticide use according to the product labels and also according to their own initiative when signs of an imminent pest attack were observed.

Most of the farmers explained that they normally mixed two or more pesticides together before spraying. This was found for both insecticides and fungicides. In all cases, the farmers commented that this practice increased the effectiveness of killing pests.

When asked about the climate factors, most answered that they took them into account when spraying, and almost all the respondents (GAP and non-GAP farmers) said that temperature or radiation and wind were the most relevant factors.

In terms of worker safety by wearing adequate clothing and gear, it was found that most of the farmers reported covering their mouths, arms and legs when spraying pesticides, although very few reported covering their feet or their eyes. Almost all said that they washed themselves after spraying. No statistically differences were found between the means of both groups.

Finally, when asked about training, 60% of the GAP farmers and 79% of the non-GAP farmers reported that they did not receive any training, although no significant differences were found between their means. Those who received training explained that it lasted for a period shorter than one day. Both groups of farmers reported that the training events were provided by the DoAE.

Discussion

The study revealed that the horticultural crops from Damnoen Saduak which were exported to different countries were produced both by GAP and non-GAP farmers. In contrast, crops that were sold in domestic markets were produced exclusively by farmers who were not GAP-certified. This points out that obtaining a license is an important requirement (if not the most) for enabling farmers to gain access to international markets. Actually, according to the interviews with farmers some of the trading companies that deal with the produce from this area request farmers to have the GAP certificate.

In this sense, the GAP program seems to be successful by allowing individual and groups of farmers to

Table 3. Pest control and pesticide handling by GAP farmers compared to non-GAP farmers.

Questions	GAP (total number : 50)		Non-GAP (total number : 80)		t-test[2]	
	No.[1]	Percent	No.[1]	Percent	t value	significance
Method of pest control:						
Use of synthetic pesticide	50	100	80	100	-	-
Use Only synthetic?	36	72.0	67	83.7	1.5	ns[3]
Pesticide handling						
Use of pesticide in preventive way?	46	92.0	75	93.7	0.4	ns
Follow label instructions?	42	84.0	67	83.7	0.1	ns
Apply by own initiative	46	92.0	65	81.2	1.8	ns
Do you mix insecticide and fungicide	44	88.0	69	86.2	0.3	ns
Mix pesticides (ins-ins or fungi-fungi)?	50	100	77	96.2	1.7	ns
Take into account temperatures and wind	50	100	78	97.5	1.4	ns
Protection						
(a) hat	45	90.0	65	81.2	1.4	ns
(b) mask	10	20.0	21	26.2	0.8	ns
(c) aymong (balaclava)	45	90.0	73	91.2	0.2	ns
(d) long sleeve shirt	46	92.0	78	97.5	1.6	ns
(e) long pants	46	92.0	74	92.5	0.9	ns
(f) boots	1	2.0	1	1.2	0.3	ns
(g) gloves	2	4.0	4	5.0	0.3	ns
(h) glasses	0	0	1	1.2	1.0	ns
(i) ninja Shoes	1	2.0	3	3.7	0.6	ns
(j) shower after spraying/wash clothes	50	100	80	100	-	-
Training						
Received training in past 2 years.						
(a) less than 3 hrs	7	14.0	5	6.2	1.2	ns
(b) 3 hrs	5	10.0	6	7.5	0.8	ns
(c) 1 day	3	6.0	1	1.2	1.3	ns
(d) cannot remember	5	10.0	5	6.2	0.8	ns
(e) not trained	30	60.0	63	78.7	1.3	ns

[1] No. is the number of farmers who answered affirmatively to the question.
[2] Two-tailed two samples mean comparison test with unequal variances.
[3] ns; not significant at the 0.05 level.

benefit economically from gaining access to new markets. Amekawa (2013) has highlighted the practical usefulness of the GAP program, describing it as a counterforce to major private Good Agricultural Practices approaches such as Global GAP, which although contributing to the improvement of worker safety, pesticide use, and environmental protection, tend to cater to the interests of wealthy large-scale producers.

From the food security standpoint though, the results showed that the implementation of the standard is still incipient. We observed that most of the farmers preferred to use the same types of synthetic pesticides. We could not find evidences suggesting that the GAP farmers opted to use less hazardous pesticides compared to the non-GAP farmers, despite the fact that the standard incorporated the principles of alternative pest management strategies such as those of Integrated Pest Management. Instead, we observed that the most frequently reported synthetic pesticide used by both groups of farmers was Methomyl, which was also the most hazardous.

A proportion of farmers from both groups reported that they regularly used non-synthetic pesticides, alternating the use with the synthetic ones, although the main reason seemed to be unrelated to environmental or health concerns but related to cost reduction.

One significant finding that exposed a deficiency in the implementation of the GAP standard was that none of the initial fifty GAP farmers surveyed were keeping records of their pest management activities, therefore preventing audits from being conducted by the DoA. This situation did not allow to evaluate how well the agricultural practices were adopted in terms of standard compliance.

The DoA itself has recognized that its efforts in controlling farmer practices are centered mainly on the final stage of crop production, through the testing of pesticide residues in fruits and vegetables before they are available to consumers (Sardsud, 2007; Wannamolee, 2008; Schreinemachers *et al.*, 2012; Amekawa, 2013).

Overlooking the monitoring of on-farm stages of food production can expose workers and the environment to preventable risks caused by pesticides. For instance, the practice of preventive spraying reported by the GAP farmers (and non-GAP farmers alike) may denote a misuse or overuse of pesticides which cannot be assessed or even identified by monitoring efforts such as residue testing. This stresses the importance of data recording for use in audits necessary for successful implementation of the GAP program by farmers.

In terms of pesticide handling and worker protection, GAP farmers were not performing better than the non-GAP farmers. This suggests that the working conditions of the GAP farmers had not become safer since the onset of the program and that they may be exposed to the same health and safety risks as the other farmers in the area.

The underlying factor by which the compliance with the GAP requirements proved to be a difficult task for the farmers may be due to a deficiency or lack of training from the DoAE. This in turn may be attributable to insufficient governmental resources; particularly, a shortage of professional officers to supervise the GAP implementation processes of all the farmers who required a license.

A deficient training component in GAP matters cannot ensure that farmers will be able to improve their current pesticide use practices towards better food security, worker safety and prevention of environmental degradation, the main principles of the GAP standard.

Our results indicate that the GAP program has focused so far on the broad certification of farmers so that they are not excluded from access to the markets, which otherwise would not be available to them. But to achieve this objective, the criteria for granting the GAP license had to be set loose. Research from Amekawa (2013) shows that this situation is not exclusive to Damnoen Saduak and its raised beds' intensive horticultural management system, but that it also occurs for pummelo production systems under the agroecological conditions of highland and lowland areas. When comparing two pummelo production sites in Chaiyaphum province, Amekawa found that GAP certification criteria were set loose, and that this fact conferred the strength of the public GAP approach, compared to the private ones.

The broad inclusion of farmers into the program can be seen as the first step towards the GAP standard implementation. The next challenges to be met by the MoAC should be to focus on control along the on-farm stages of crop production (audits) and on effective training of the farmers in IPM methods or other viable pest management alternatives in order to reduce the amount of synthetic pesticide use and reach the other objectives of the GAP program.

Acknowledgements

We are grateful to Aphiradee Kimpithak for helping out with data collection and translating the surveys to English. We would also like to thank the Department of Agricultural Extension (DoAE) and its officers for providing valuable information and assistance. We thank the farmers from Damnoen Saduak, especially the Jaroensub family, who kindly provided their support and shared their knowledge during our stay. This study was supported by a Grant-in-Aid for Scientific Research (Grant No. 23248055).

References

Amekawa, Y. 2013. Can a public GAP approach ensure safety and fairness? A comparative study of Q-GAP in Thailand. J. Peasant Stud. **40**: 189-217.

Athisook, K., B. Sungwaranon, Y. Lertreungdej, P. Jongmeevasana, T. Payanant, and R. Chaipol-ngam 2007. Pesticide residue in foods monitored in Thailand, 1999-2003. In: "Pesticides in Southeast Asia: Environmental, biomedical, and economic uses and effects, ed. P. Kunstadter", pp. 151-159.

Cheyroux, B. 2003. Fruits and vegetables in Thailand's rice bowl: The agricultural development of poldered raised bed systems in the Damnoen Saduak area. Perspectives on social and agricultural change in the Chao Phraya Delta: 157-176.

Ehler, L. E. 2006. Integrated pest management (IPM): definition, historical development and implementation, and the other IPM. Pest Manage. Sci. **62**: 787-789.

FAO 2007. Report of the FAO Expert Consultation on a Good Agricultural Practice approach. Rome, ITALY 10 - 12 November 2003. Document prepared by Neely C., B. Haight, J. Dixon, A. Poisot. Rome. [Online] http://www.fao.org/prods/GAP/DOCS/PDF/1-reportExpertConsultationEXTERNAL.pdf (browsed on Feb. 13th, 2014).

FAO 2014. Pesticide use. In "FAOSTAT". Rome, Italy. [Online] http://faostat.fao.org/site/424/DesktopDefault.aspx?PageID=424#ancor (browsed on Dec. 1st, 2014).

Henson, S. and J. Humphrey 2010. Understanding the complexities of private standards in global agri-food chains as they impact developing countries. J. Dev. Stud. **46**: 1628-1646.

Heong, K. and K. Schoenly 1998. Impact of insecticides on herbivore-natural enemy communities in tropical rice ecosystems. In: "Ecotoxicology", pp. 381-403. Springer.

Humphrey, J. 2006. Policy implications of trends in agribusiness value chains. Eur. J. Dev. Res. **18**: 572-592.

IRRI 2011. International Rice Research Institute supports Thai move to stop insecticide use in rice. [Online] http://irri.org/news/media-releases/irri-supports-thai-move-to-stop-insecticide-use-in-rice (browsed on Aug 02, 2013).

Kogan, M. and W. I. Bajwa 1999. Integrated pest management: a global reality? An. Soc. Entomol. Bras. **28**: 01-25.

Matson, P. A., W. J. Parton, A. Power, and M. Swift 1997. Agricultural intensification and ecosystem properties. Science **277**: 504-509.

Mausch, K., D. Mithöfer, S. Asfaw, and H. Waibel 2006. Impact of EurepGAP standard in Kenya: Comparing smallholders to large-scale vegetable producers. In: "Conference on International Agricultural Research for Development, Bonn, October".

Molle, F., C. Sutthi, J. Keawkulaya, and R. Korpraditskul 1999. Water management in raised bed systems: a case study from the Chao Phraya delta, Thailand. Agric. Water Manage. **39**: 1-17.

Nadvi, K. and F. Waltring 2004. 3. Making sense of global standards. Local enterprises in the global economy: Issues of governance and upgrading: 53.

National Bureau of Agricultural Commodity and Food Standards (NBACFS) 2009. "Good Agricultural Practices for Food Crops". Royal Gazette, Chatuchak, Bangkok, Thailand. Vol. 126, Iss.

Panuwet, P., W. Siriwong, T. Prapamontol, P. B. Ryan, N. Fiedler, M. G. Robson, and D. B. Barr 2012. Agricultural pesticide management in Thailand: status and population health risk. Environ. Sci. Policy **17**: 72-81.

Pimentel, D., H. Acquay, M. Biltonen, P. Rice, M. Silva, J. Nelson, V. Lipner, S. Giordano, A. Horowitz, and M. D'amore 1992. Environmental and economic costs of pesticide use. Bioscience: 750-760.

Praneetvatakul, S., P. Schreinemachers, P. Pananurak, and P. Tipraqsa 2013. Pesticides, external costs and policy options for Thai agriculture. Environ. Sci. Policy **27**: 103-113.

Rerkasem, B. 2005. Transforming subsistence cropping in Asia. Plant Prod. Sci. **8**: 275-287.

Sardsud, V. 2007. National Experiences: Thailand. In: "Challenges and Opportunities Arising from Private Standards on Food Safety and Environment for Exporters of Fresh Fruit and Vegetables in Asia: Experiences of Malaysia, Thailand and Viet Nam", pp. 53-69. United Nations Conference on Trade and Development.

Schreinemachers, P., I. Schad, P. Tipraqsa, P. M. Williams, A. Neef, S. Riwthong, W. Sangchan, and C. Grovermann 2012. Can public GAP standards reduce agricultural pesticide use? The case of fruit and vegetable farming in northern Thailand. Agric. Human Val. **29**: 519-529.

Srithamma, S., J. Vithayarungruangsri, and T. Posayanonda 2005. Food safety programme: a key component for health promotion. Acessed January **21**: 2010.

Tallontire, A., M. Opondo, V. Nelson, and A. Martin 2011. Beyond the vertical? Using value chains and governance as a framework to analyse private standards initiatives in agri-food chains. Agric. Human Val. **28**: 427-441.

Thapinta, A. and P. F. Hudak 2000. Pesticide use and residual occurrence in Thailand. Environ. Monit. Assess. **60**: 103-114.

Wannamolee, W. 2008. Development of Good Agricultural Practices (GAP) for fruit and vegetables in Thailand. Sheraton Subang Hotel & Towers for Training of Trainers in Good Agricultural Practices (GAP) and Benchmarking: GLOBALGAP for Fruit and Vegetables: 14-23.