Agric Hum Values (2012) 29:519–529
DOI 10.1007/s10460-012-9378-6

Can public GAP standards reduce agricultural pesticide use? The case of fruit and vegetable farming in northern Thailand

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Accepted: 23 March 2012 / Published online: 12 June 2012

Abstract In response to the chronic overuse and misuse of pesticides in agriculture, governments in Southeast Asia have sought to improve food safety by introducing public standards of good agricultural practices (GAP). Using quantitative farm-level data from an intensive horticultural production system in northern Thailand, we test if fruit and vegetable producers who follow the public GAP standard use fewer and less hazardous pesticides than producers who do not adhere to the standard. The results show that this is not the case. By drawing on qualitative data from expert interviews and an action research project with local litchi ("lychee") producers we explain the underlying reasons for the absence of significant differences. The qualitative evidence points at poor implementation of farm auditing related to a program expansion that was too rapid, at a lack of understanding among farmers about the logic of the control points in the standard, and at a lack of alternatives given to farmers to manage their pest problems. We argue that by focusing on the testing of farm produce for pesticide residues, the public GAP program is paying too much attention to the consequences rather than the root cause of the pesticide problem; it needs to balance this by making a greater effort to change on-farm practices.

Keywords Certification · Food safety · Food standards · Good agricultural practices · Pesticide contamination · Southeast Asia

Abbreviations

ACFS	National Bureau of Agricultural Commodity and Food Standards
ASEAN	Association of Southeast Asian Nations
DoA	Department of Agriculture
DoAE	Department of Agricultural Extension
GAP	Good agricultural practices
IPM	Integrated pest management
MoAC	Ministry of Agriculture and Cooperatives
MRL	Maximum residue limit

Introduction

Chronic overuse and misuse of agricultural pesticides characterizes crop production in many parts of Southeast Asia as well as in China, exposing farmers, consumers, and ecological systems to the risk of pesticides (Xu et al. 2008; Schreinemachers et al. 2011; Mazlan and Mumford 2005; Van Hoi et al. 2009; Lamers et al. 2011; Panuwet et al. 2008). To address this problem, several countries in the region have recently introduced public standards of good agricultural practices (GAP) aimed at increasing the supply

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of safe and high quality food by promoting a more sustainable crop production that uses fewer pesticides.

Like many other countries undergoing rapid economic development, Thailand is experiencing a very sharp increase in pesticide use, such that the per hectare use of active ingredients grew by 11 % per annum from 1997 to 2010 (Praneetvatakul et al. 2011). The contamination of food with pesticides is a serious problem in Thailand, as has been highlighted by many scholars (e.g., Athisook et al. 2007; Hongsibsong et al. 2007; Posri et al. 2006; Tanabe et al. 1991). Recent instances of contamination of food exports with pesticide residues and the resulting restrictions imposed by importing countries point to the importance of the issue. At the same time the Thai government is trying to strengthen the country's position as a major exporter of fresh fruit and vegetables.

The first objective of this study is to test whether farm managers using a public GAP standard do indeed apply fewer synthetic pesticides than farmers who do not follow such a standard and whether they select pesticides that are on average less hazardous to human health. The second objective is to understand the reasons why public GAP standards do or do not contribute to reducing agricultural pesticide use. These two objectives are addressed by combining quantitative data from a random sample of farm managers in northern Thailand with qualitative data from interviews with Thai government authorities and an action research project which focuses on a group of farmers using the public GAP standard.

The wider empirical relevance of our study stems from the fact that although many countries in Southeast Asia, such as Indonesia, Malaysia, Philippines, Thailand, and Vietnam, have recently introduced public GAP standards, published studies on the impact of these programs remain few in number. This study hence examines the public GAP standard in Thailand as a test case for other countries in the region. Studying pomelo (*Citrus maxima*) growers in northeast Thailand, Amekawa (accepted) observed a broad participation of small-scale farmers in the program, while at the same time concluded that their compliance with control points was very poor. He attributed this to a lack of understanding among farmers of the GAP principles and a lack of economic rewards as certification did not give farmers access to higher value markets. Understanding the strengths and weaknesses of public GAP standards is important also because member countries of the Association of Southeast Asian Nations (ASEAN) are in the process of harmonizing their national public GAP standards in order to promote the mutual acceptance of standards across their borders, and thereby enhance trade opportunities.

Our study is of particular relevance as it helps us understand the degree to which public standards could be a viable alternative to private standards such as GlobalGAP—a standard developed by a consortium of European retailers, which has become the leading GAP standard globally (Humphrey 2006; Tallontire et al. 2011). Although some studies have shown that the use of private standards in developing countries increases farm incomes and lowers pesticide-related health costs (e.g., Okello and Swinton 2010), the majority of studies have been rather critical. Some studies have shown that having to comply with private standards acts as a non-tariff trade barrier, which limits the competitiveness of lower income countries (e.g., Chen et al. 2008; Wilson and Otsuki 2004; Henson and Jaffee 2008). Other studies have raised concerns about the democratic legitimacy of private standards (e.g., Busch 2009; Fuchs et al. 2011), while others have pointed at the high levels of investment that favor large-scale producers over smallholder farmers (e.g., DeLind and Howard 2008; Amekawa 2009). As smallholder farming is the dominant form of agriculture in Southeast Asia, public GAP certification, which is free of charge to farmers, might be a better alternative in the region. Yet we note that a direct comparison between public and private standards is beyond the scope of this study.

The next section begins with an account of the three types of data used in this study: qualitative data from interviews with government officers, quantitative data from a farm household survey, and qualitative data based on action research. The subsequent three sections will present the results of each type of data collected. First, we describe the development of GAP standards in Thailand based on interviews with the government officers. Second, we compare pest management practices and pesticide use between farmers who do and farmers who do not follow the public GAP guidelines based on quantitative data from structured farm surveys. Third, we analyze the underlying incentives for farmers to comply with the standard as well as potential constraints to compliance based on action research data. The final section reflects upon the results in light of previous studies and draws policy relevant conclusions with respect to improving public standards.

Methods and data

Combining qualitative with quantitative methods

To better understand the workings of the public GAP certification process in Thailand, we conducted expert interviews with senior government officers in charge of the program. We interviewed the head of the Q-GAP program in Bangkok to determine the objectives of the program, its organization, its size, and current challenges. We also interviewed the regional program director in Chiang Mai to better understand how the GAP standard is implemented and how the auditing is being conducted. Lastly, we interviewed an officer at a government laboratory in Chiang Mai to learn how the testing for pesticide residues is being carried out.

Using a structured questionnaire, we further interviewed 295 farm managers in one watershed in northern Thailand who use an intensive horticultural production system, as introduced in the following subsection. The survey involved a twelve-month recall period, from April 2009 to March 2010, and recorded detailed information on crop management practices, pesticide use, pesticide handling, and household characteristics. It was found that 50 farm managers follow the public GAP guidelines on at least one of their plots, with five also following GlobalGAP. We dropped these latter five from our analysis, as our focus is on the public GAP. The survey data allowed us to quantify factual differences between the farmers and their cropping cycles (i.e., those using and those not using the public GAP standard). In order to explain these differences and to obtain a more thorough understanding of how public GAP standards change farming practices, we complemented the survey data with qualitative data collected in the same study area, but independently from the survey. Both the quantitative and qualitative data were collected as part of a larger research program with more broadly defined objectives.

The qualitative part of the project employed an action research method in which two researchers supported by two assistants linked a group of about 100 farm managers growing litchis (*Litchi chinensis* Sonn. or "lychee") directly to high-value markets, and then observed the resulting opportunities and constraints. Litchi was selected because it is the most important crop in terms of hectares in the study site and because several authors of this study have been involved in an action research project on litchi marketing networks in the area, providing direct and unique insights into the reality of the public certification process (see Tremblay and Neef 2009). The high-value markets consisted of a British hypermarket chain that aims to buy directly from growers and requires public GAP certification, and exporters to the European Union, which require GlobalGAP certification. As the emphasis of this paper is on public certification, we will report only on the first marketing channel. The role of the researchers was to facilitate the contact between the group of farmers, the government agencies implementing the public GAP scheme, and the agent for the hypermarket chain. Through this role, the researchers were able to collect data from participant observations during farmer meetings. Additional data were gathered from individual interviews that focused on farmers' perceptions of the standard as well as the motivations and constraints they experienced in terms of standard compliance. All interviews were recorded and transcribed. Observational data were kept in a standardized form and analyzed using content analysis, in line with Mayring (2003).

The combination of three data collection methods allowed us to look at the public GAP program from different angles. While the quantitative part made it possible to statistically test for differences in pesticide use, the action research approach was more useful for explaining possible differences. The expert interviews helped us see the case study in the wider context of program objectives and their implementation.

Study area

We selected the Mae Sa watershed in Chiang Mai Province in northern Thailand as the study area for farm-level data collection (Fig. 1). This watershed is characterized as having good access to input and output markets, and contains intensive upland agriculture. The combination of high levels of pesticide use and a relatively large number of farmers in the public GAP program made it a suitable area to use for the study. The main crops grown in the area are litchis, which are grown on the slopes, and bell peppers, which are grown in greenhouses in the watershed's central valley. Other crops grown include tomatoes and cucumbers—both grown in greenhouses—and chayote (*Sechium edule*), cabbages, lettuce, chrysanthemums, and roses.

The intensification of agriculture has been accompanied by heightened pest pressure and the development of resistance to pesticides in some pest populations. For example, farmers growing bell peppers, one of the most profitable crops in the area, struggle to control thrips, viruses, and powdery mildew, while fruit borer, shield bugs, and downy mildew are major pests with litchis. In addition, cabbages are frequently infested by webworms, beet armyworms, common cutworms, cabbage loopers, and diamondback moths.

Farmers try to protect their market crops from these pests by resorting to a vast array of chemical fungicides and insecticides. Schreinemachers et al. (2011) estimated that farmers in the watershed use an average of 13 kg/ha of active ingredients per year, which is high when compared to the average application rate of about 3.6 kg/ha per year for Thailand as a whole (Praneetvatakul et al. 2011). The main insecticides used are abamectin and cypermethrin, while mancozeb is the most commonly used fungicide. Farmers prefer to use toxic substances that can quickly eliminate pests.

The development of GAP standards in Thailand

The Thai government declared 2004 to be the 'Year of Food Safety' in order to increase consumer confidence in

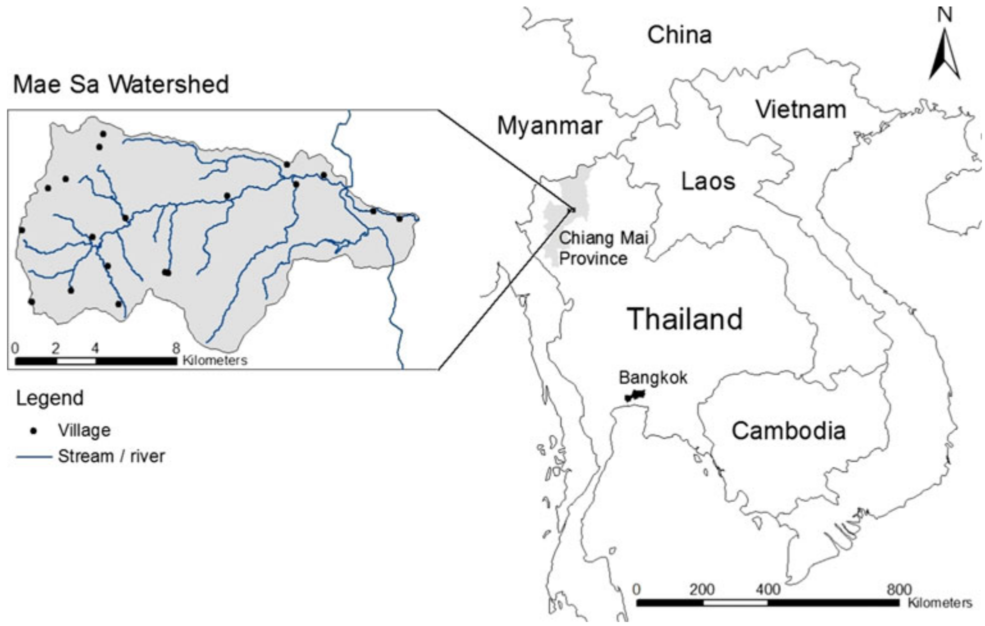

Fig. 1 Map of the study area location in Thailand

the Thai food sector through the improvement of food quality and food safety. One measure introduced was a public standard for GAP, called Q-GAP (with the Q standing for quality). As with other public GAP standards in Southeast Asia—IndoGAP in Indonesia, VietGAP in Vietnam, PhilGAP in the Philippines, and SALM in Malaysia—the Thai standard is fully managed by the government, from standards setting to training, auditing, and the issuing of certificates (Sardsud 2007). The National Bureau of Agricultural Commodity and Food Standards (ACFS), established in 2002, is the accreditation body that sets the standards (following ISO/IEC guide 65) and assesses the competence of those organizations doing the auditing and certification (Sardsud 2007). Table 1 provides a chronology of these and other institutional changes related to food standards in Thailand.

The Q-GAP program has expanded rapidly since its introduction in 2004 and is currently the largest GAP program in Southeast Asia. While the standard is set by the ACFS, the program implementation is managed by two departments of the Ministry of Agriculture and Cooperatives (MoAC): the Department of Agricultural Extension (DoAE), which has overall responsibility for the program, and the Department of Agriculture (DoA), which is in charge of the farm auditing and issuance of GAP certificates. Through the expert interviews, we learned that the MoAC has set clear targets for expanding the number of producers operating within the program and that certification, originally available for 29 crops, has since expanded to cover 128 fresh fruits and vegetables.

Certificates are issued free of charge to farmers and are valid for one year for seasonal crops and two years for perennial crops. From official documents we found that in 2010 certificates were issued to about 212,000 farmers covering a crop area of 225,000 hectares. Although this area seems large, it represents only 3.7 % of the country's farm households and 1.2 % of the area of arable and permanent cropland.

The auditing of farms under the Q-GAP program has strained the handling capacity of the DoA, which is the certifying body for the program. For instance, in the northern region there are about 120 DoA auditors but about 140,000 registered farmers, suggesting that each auditor is responsible for processing over 1,000 farmers a year. According to the same DoA officer, there is current nationwide capacity to audit about 10,000 farms a year.

In recent years, auditing has been increasingly carried out by local contractors in a system designed to ensure the expansion of the Q-GAP program. The DoAE provides training in GAP auditing to government officers through a four-day training course, with a refresher course after 3–6 months. These trained government auditors in turn train a large number of other people who are hired on a temporary basis to conduct GAP audits and are paid per audit. According to a DoA officer in Chiang Mai, about 70 % of the auditing is currently done by contractors. Privatization of the entire monitoring system is being considered, but a decision on this has been delayed because the costs are unclear. Government laboratories, together with a few accredited private laboratories, do all the residue testing but have been overloaded with samples.

The Q-GAP guidelines are based on eight principles that cover a wide range of farm management issues, such as site selection and management, agrochemical use, and water supplies (DoA 2009). The clear emphasis is, however, on food safety, and more narrowly on the contamination of

Table 1 Main institutional changes related to food standards in Thailand

1988	First national GAP scheme introduced
1995	Organic Agriculture Certification Thailand (ACT) established
2000	Ministry of Agriculture and Cooperatives defines organic crop production standards
2002	Establishment of the National Bureau of Agricultural Commodity and Food Standards (ACFS)
2004	Government declares food safety year
	Start of Q-GAP program (managed by MoAC)
2005	Start of ThaiGAP (private standard)[a]
2006	ASEAN countries agree on AseanGAP standard
2008	Implementation of Globally Harmonized System of Classification and Labeling of Chemicals (GHS), and the safety data sheet (SDS)
2010	ThaiGAP standard harmonized with GlobalGAP
2012	Q-GAP standard supposed to be harmonized with AseanGAP

[a] ThaiGAP is a private standard mostly aimed at the EU market. The standard, which started in 2005, is set by the Thai Chamber of Commerce and Board of Trade of Thailand and the auditing is done by a private company (NSF-CMi). Less than ten farms received the ThaiGAP certificate in 2011

farm produce with pesticide residues. The Q-GAP auditing reflects this, as the main effort goes into the testing of harvested products for pesticide residues. While Q-GAP guidelines emphasize farm practices that are pre-farm gate, auditing focuses on the final stages of production. The standard requires farmers to record their use of agro-chemicals and to use them in a proper way, but farmers are likely to receive a certificate as long as they observe the prescribed pre-harvest spraying interval (that is, a number of days before the harvest during which time farmers are not allowed to spray pesticides). In addition, we observed that official documents recognize integrated pest management (IPM) to be an integral part of Q-GAP, yet guidelines mostly tell farmers how to apply certain chemicals, with little or no mention of alternatives.

The emphasis on pesticide contamination shows the importance of this issue for the Thai food sector. Local media regularly report about high concentrations of chemicals in the blood samples of farmers and consumers, and in 2010, EU customs officials detected pesticide residues on Thai vegetables that exceeded the maximum residue limits (MRLs) by 55 times. In early 2011, Thailand voluntarily suspended exports of sixteen types of vegetables to the EU, after the EU threatened to ban imports of Thai vegetables due to pest and pesticide residues having been found. Thereafter, random sampling in Thailand was increased to cover 50 % of vegetable shipments to the EU for a period of six months.

The bulk of Thailand's fruit and vegetable exports are shipped to other countries in Southeast Asia, with only a relatively small volume shipped to the EU and Japan (Sardsud 2007). Trade in agricultural products within Southeast Asia and with China is likely to continue to increase as the region moves towards a single market in 2015—the ASEAN Economic Community. To reduce barriers in agricultural trade, ASEAN countries in 2006 agreed to harmonize their national public GAP standards to form a new AseanGAP standard by 2012. The AseanGAP standard is more comprehensive than the Q-GAP standard, as it includes five additional areas including planting materials, soil and substrates, biodiversity, worker welfare, and reviewing practices. Unlike the Q-GAP standard, AseanGAP will require using IPM whenever possible (ASEAN 2008; DoA 2009).

Comparing the intensity of pesticide use between Q-GAP and non-GAP farmers

Table 2 compares pest management practices between farmers from the study area who do and do not follow the Q-GAP guidelines. As can be seen from the table, nearly all farmers use synthetic pesticides, with just four out of 290 farmers using only non-synthetic methods of pest control, and with 84 % of the Q-GAP farmers and 77 % of non-GAP farmers relying solely on synthetic pesticides to control crop pests (the difference not being significant). Only 14 % of the Q-GAP farmers apply non-synthetic methods such as insect traps, bio-pesticides, or mechanical control methods.

In terms of pesticide handling, no significant differences were found between farmers who do and do not follow the Q-GAP guidelines. Of those Q-GAP farmers who use synthetic pesticides, 41 % spray at regular intervals irrespective of the level of pest infestation. The majority of farmers (78 % of the Q-GAP group) determine the dosage by following product labels. When asked an open-ended question as to what climate factors they take into account when spraying pesticides, 88 % of the Q-GAP respondents indicated that temperature or radiation (sunshine) are important, but only 27 % mentioned wind, wind speed, or wind direction. Regarding protective clothing, we found that the majority of farmers cover their mouths, arms, and

Table 2 Pest control and pesticide handling by non-GAP farmers compared to Q-GAP farmers, as a percentage of all farmers in the group

Pesticide handling aspect	Non-GAP	Q-GAP	*t* test[c]
Methods of pest control[a]			
Use synthetic pesticides	96	98	NS
Rely solely on synthetic pesticides to control pests	77	84	NS
Use non-synthetic methods to control pests	21	14	NS
Pesticide handling[b]			
Use pesticides in a preventive way (regular spraying)	41	45	NS
Follow product labeling to decide on dosage to use	80	78	NS
Take temperature or radiation into account when spraying	86	88	NS
Take wind speed and/or direction into account when spraying	24	27	NS
Cover mouth when spraying	76	81	NS
Cover arms and legs when spraying	86	95	NS
Take a shower and wash clothes after spraying	47	60	NS
Number of farm managers interviewed	245	45	

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$; *NS* not significant at 0.10

[a] Percentage of all farmers in the group

[b] Percentage of farmers using synthetic pesticides

[c] Two-tailed two-sample mean comparison test with unequal variances

legs during spraying, but much fewer respondents said that they take a shower or change their clothes afterwards. These findings suggest that the majority of farmers in both groups make efforts to reduce the direct risk of pesticide spraying on their health, yet depend heavily on synthetic pesticides in their pest control practices.

We further compared pesticide use between the Q-GAP and non-GAP farmers at the crop level, because certificates are assigned not to farmers but to plot-crop combinations. We had a relatively large number of crop-level observations for bell peppers, cabbages, and lettuce, but much fewer observations for other crops. Only for those crops with a minimum of five observations did we carry out a *t* test to assess the differences in mean values.

The results in Table 3 confirm those seen in Table 2 that the majority of farmers rely solely on synthetic pesticides for their pest management. The exception is chayote, which is not significantly affected by pests. In terms of the average quantity of pesticides applied, Q-GAP farmers use smaller quantities on average for all crops mentioned in the table, but as variations in pesticide use are large, these differences are not significant ($p > 0.10$) for any crop.

We further compared the share of pesticides used that are classified as extremely hazardous (WHO class Ia), highly hazardous (Ib), and moderately hazardous (II) in terms of the total quantity of active ingredients, as the use of these pesticides should be minimized under the Q-GAP standard. Table 3 shows that for bell peppers ($p < 0.05$), the share of these hazardous chemicals used as a proportion of the total pesticide quantity applied is lower in fields using Q-GAP than in fields not using GAP. However, for lettuce ($p < 0.01$) and Chinese cabbage ($p < 0.10$) we find the opposite: the share of hazardous chemicals in total pesticide use is greater for Q-GAP. For the four other crops tested we did not find a significant difference.

Farm level constraints and incentives regarding GAP compliance

Having shown that Q-GAP certification has no significant effect on pesticide handling or the amount of pesticides used and only significantly reduces the use of highly hazardous pesticides for one out of eight crops, we now turn to the qualitative data to understand the underlying reasons.

The Q-GAP guidelines for litchi are extensive, with nearly a hundred control points laid down over three field manuals. Control points are organized in four areas as listed in Table 4. For the main control points, we compared the required practices with the actual practices of the farmers, and observed how each control point is inspected by the Q-GAP auditor.

According to the Q-GAP guidelines, farmers registered in the Q-GAP program should receive technical assistance from the DoAE about IPM, integrated crop management, and organic compost making. In reality, no technical assistance was provided to any of the farmers. Although farmers are supposed to reduce their synthetic pesticide use, there was no training provided. Moreover, the field manuals gave no information on how to replace synthetic pesticides with alternative methods of pest control.

According to the Q-GAP guidelines, first-time certification should involve three audits, to take place without

Table 3 Pesticide use by crop (with and without Q-GAP standards applied)

Crop	Non-GAP				Q-GAP			
	N	Use pesticides only (%)	Active ingredients (kg/ha) (SD)	WHO Ia, Ib, II (%)[a]	N	Use pesticides only (%)	Active ingredients (kg/ha) (SD)	WHO Ia, Ib, II (%)[a]
Bell peppers	157	79	43.02 (126.04)	39	41	72	23.69^{NS} (28.7)	27**
Cabbage (white/ pointed)	131	87	4.60 (22.83)	62	21	89	1.20^{NS} (1.33)	59^{NS}
Carrots/potatoes	33	85	4.78 (11.35)	16	6	78	0.56^{NS} (0.53)	25^{NS}
Chayote	86	20	1.32 (6.54)	66	4	0	0.00† (0)	0†
Chinese cabbage	123	87	4.31 (8.82)	38	21	98	1.53^{NS} (2.18)	55*
Lettuce (various)	50	72	1.88 (3.27)	26	22	95	1.29^{NS} (2.29)	78***
Litchis	121	43	4.50 (42.05)	33	9	89	3.38^{NS} (5.93)	17^{NS}
Tomatoes	18	78	21.02 (28.3)	32	10	100	20.61^{NS} (18.01)	30^{NS}

N is the number of crop cycles observed

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$; *NS* not significant at 0.10. † No *t* test was performed for chayote ($N < 5$)

[a] Share of active ingredients of WHO hazard classes Ia, Ib, and II in the total quantity of active ingredients used. Two-tailed two-sample mean comparison test with unequal variances

advance notification in terms of the date and time. In reality, the farmers had been visited only once and were informed about the date and time of the audit in advance. Auditing of the litchi orchards was done by relatively young and inexperienced government auditors who spent as little as 5 min with each farmer and largely avoided walking into the orchard because of the limited time available. Perhaps because of the large age difference between the auditor and the farmers, critical remarks towards the farmers were mostly avoided during the audit, reflecting a society in which hierarchy and respect for seniors are very important. The friendly style of the auditing suggested that farmers were unlikely to fail.

The farmers said that categories A (orchard management) and B (equipment storage and management) of the standard are relatively unproblematic in terms of implementation. Submitting basic plot information and making the orchard look “neat and clean” before the auditor’s visit is perceived as an easy task. Farmers said that category C (handling and use of chemicals) is a bit more difficult, as they need to find out what chemicals can be used, place them in a storage and change their chemical handling processes as well as the timing of pesticide applications. However, the required changes are minor as compared to conventional practices, and are therefore feasible to adopt. Moreover, these changes do not require additional labor or other costs, and the spraying schedule defined in the field manual is largely the same as what the farmers were used to before, except for the prescribed pre-harvest interval, as farmers used to spray right up until harvesting. While all the farmers stated during the interviews that they comply with the pre-harvest intervals, field observations showed that several farmers do spray right up to the harvest. However, the farmers know that only a few fruit samples will be collected for residue analysis and that the risk of getting caught by the audit is therefore low, whereas the risk of losing a part of the harvest due to pests is high. The most difficult category of control points to follow is record keeping (category D), because farmers are unfamiliar with this and a few of the older farmers we spoke to possess a low level of literacy.

In most cases farmers do not understand the underlying rationale for these guidelines and therefore do not feel intrinsically motivated to follow them, but rather perceive the guidelines as requirements that need to be fulfilled explicitly and exclusively for the audit. As a result, most guidelines are only implemented immediately prior to the audit. Since auditing involves a one-time visit and very few samples for pesticide residue analysis, the incentive for long-term compliance is low. In addition, there is a lot of leeway allowing farmers to bypass certain guidelines such as those about the handling and appropriate disposal of

Table 4 Control points in the Q-GAP standard for litchi, actual on-farm practices and the auditing of standard compliance

Control points[a]	Actual practices	Q-GAP audit
A: Orchard management		
A statement of plot size and location must be submitted	Farmers record information on application form	Random checks with land registration office
Sources of irrigation water (wells, lakes, rivers, etc.) and location must be identified	Farmers record information on application form	On-spot inspections
Potentially hazardous factors with regard to water quality must be identified	Only stated if really obvious and might be detected during field audit	Auditor takes a few randomized water samples
Orchard should look neat and clean	Farmers clean up their orchard before audit, but most do not pay attention to it afterwards	Auditor has one-time, quick look at the orchard
B: Equipment storage and management		
Tools must be stored in a sheltered location	Tools are stored in makeshift huts in orchard or in wooden boxes	Auditor checks storage
Broken or unused equipment must be disposed of outside the orchard	Hardly implemented	Not monitored
C: Handling and use of chemicals		
Nationally banned chemicals may not be used	Most farmers comply; however, one farmer used banned chemicals	Random residue analysis (seldom more than once a year)
All chemicals must be stored in secure and protected place	As required	Checked by auditor
Recommendations for handling	No changes recorded; conventional practices broadly maintained, in parts strongly deviating from recommendations	Not monitored
Chemical leftovers and containers must be removed from the plot and disposed of appropriately	No major changes recorded; sloppy disposal, the same as carried out previously	Not monitored
Spraying is only allowed during predefined periods. Application must stop 15 days before harvest	No significant change to conventional practices	Not monitored except for random residue analysis
D: Record keeping		
Each working step must be recorded in a standardized field diary	As required	Field diary checked during audit. Missing information may cause exclusion from Q-GAP
Chemical names, amounts and the time of spraying must be recorded	Mostly done as required	One-time check during audit

[a] Based on the field manuals

pesticide containers and leftovers. Not long after the audit, we observed that some of the farmers returned to their conventional practice of randomly disposing leftover pesticides and empty containers in their orchards.

Despite the lack of real changes in pest management practices, the farmers acknowledged that they have become more concerned about the impacts of pesticide use, mostly on human health, as an indirect effect of Q-GAP introduction. One farmer mentioned in the interview: “Since some chemicals had been banned following Q-GAP, we had to go around and look for alternatives … Therefore, we had a chance to get into contact with new pesticides suppliers who provided us with additional information on how to handle them safely and prevent them from affecting our health.” Farmers also mentioned that they have developed a greater awareness about those substances that are legally banned, and learned the reasons for their being banned.

At an information sharing meeting on GlobalGAP organized by a lecturer from a local university, the participants agreed that Q-GAP has given them a basic understanding that quality goes beyond mere product appearance—such as the color and size of the fruit—and that they would feel motivated to adopt the stricter GlobalGAP standard in the future if there were a market for certified litchis.

Discussion and conclusion

It is impossible to generalize our findings from studying a small group of farmers following the Q-GAP standard to the entire public GAP program. We interviewed less than 0.1 % of farmers in northern Thailand and less than 0.1 % of Q-GAP certified farmers in Thailand. Levels of pesticide use in our study area are also much above the Thai average, and therefore not representative of Thai agriculture. Yet our findings are strikingly similar to those of Amekawa (accepted) for pomelo growers in northeast Thailand, who also found a lack of standard compliance due to a low motivation of farmers and a lack of understanding of control points among farmers. The information we obtained from the expert interviews also broadly confirms our field observations, which suggests that our results are valid.

The main strength of public GAP certification in Thailand is that it comes at no charge to the farmers, which lowers the hurdle for smallholders to participate as is demonstrated by the large overall number of farmers that are Q-GAP certified. Our study provides evidence, however, that the quality of certification is poor as program resources for training and auditing are spread too sparingly over the large group of participating farmers. The Q-GAP standard, as implemented at present, is therefore not a real alternative to more stringent private standards to guarantee food safety. We note that data collected in the Q-GAP program through standardized field diaries, residue testing, and farm audits are not currently used to manage the program. However, these data can provide valuable feedback and could, for instance, be used to optimize training and auditing efforts.

Our study shows that in the case of litchis, of the long list of control points set by the standards, MRLs are perhaps the only control point systematically audited, although statistically the auditing frequency is only once every 10 years. Yet interviewed farmers mentioned that even when spraying during the pre-harvest intervals, they believed that simply rinsing the produce allowed them to stay within MRLs, which points to the lack of intrinsic motivation among farmers to change their pest management practices. However, our study showed that farmers were interested to learn about the risk of pesticides and that they also had a reasonable level of knowledge about how to reduce their own exposure to pesticide risk. Creating more awareness about the risk of pesticides, including the risk of pesticide residues to consumers and the environment, would improve farmers' understanding of control points and give them a stronger motivation to comply with these control points.

Another problem with the focus on pesticide residue testing is that it merely gives a snapshot of the final stages of the farm production process and does not adequately address the root causes of the pesticide problem. The Q-GAP program does not provide farmers with suitable alternatives to their current practices. In line with this, our study shows that farmers almost entirely depend on synthetic pest control, with non-synthetic alternatives rarely being used. Although the concept of IPM frequently appears in connection with Q-GAP in policy documents, farmers did not receive IPM training, nor did the Q-GAP field manuals make concrete suggestions for farmers' voluntary use of IPM techniques. Instead, they only noted how to improve spraying practices.

To more effectively reduce pesticide use, the Q-GAP program therefore needs to pay more attention to on-farm practices and ensure that farmers have suitable alternatives to synthetic pesticides when managing pests. Q-GAP auditors, having received a two-day training only and spending as little as five minutes auditing a field in practice, are not qualified for this and it is also not part of their auditing task. The DoAE needs to complement the Q-GAP program by providing standardized IPM methods for each crop and providing training to farmers on how to use these. It is illustrative that none of the litchi farmers participating in the Q-GAP program had received technical assistance or training from the DoAE.

The findings of our study raise the question as to whether the Q-GAP program in its present form is the best policy response to the pesticide problem in the Thai agricultural sector. The strong focus on food safety—narrowly defined as the monitoring of pesticide residues on fruits and vegetables—suggests that the government is more concerned with limiting the consequences of pesticide overuse and misuse, presumably to avoid negative repercussions on food export opportunities, rather than addressing the root cause of the problem. With 41 % of the Thai labor force working in agriculture, and hence having direct contact with pesticides, the task is indeed daunting. Yet re-orienting the focus of the Q-GAP program to give greater attention to changing on-farm practices would benefit farmers and consumers alike.

Acknowledgments Funding by the *Deutsche Forschungsgemeinschaft* for the project SFB 564 is gratefully acknowledged. The sixth author thanks the *Hermann Eiselen Gedächtnisstiftung* for its financial support. Aer Sirijinda and Sureeporn Sringarm managed the farm survey; Chomphoonut Yotpranan, Narin Vannavijit, and Rungaroon Kantapa provided valuable research assistance. We thank the editor, Harvey James, and three anonymous reviewers for their thoughtful comments that helped to improve this paper. Gary Morrison helped with reading through the English.

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