Investigating the Factors and Patterns of Q-GAP Adoption by Rice Farmers in Ayutthaya Province, Central Region of Thailand

by

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Abstract

Increasing concerns for improved food safety, quality, and appropriate environmental practices of on-farm operations calls for setting standard practices to fulfill and steer Thailand towards more competitive edge internationally. Voluntary and free of charge Good Agricultural Practices (GAP) certification specific for rice, implemented by the government in Thailand aimed to mobilize farmers to improve on-farm operations using appropriate amount of agrochemical applications and techniques while reducing cost of production. The study is a 2-stage investigation into the factors and patterns of GAP rice adoption and continued adoption using binary regression model and means comparison analysis for 250 individual farmers from Ayutthaya Province, central region of Thailand. Results showed education, knowledge of neighbors being involved in the program, non-governmental channel about the program, smaller size of farm size, government promotion, expectations on cost reduction and expectation on price are among the factors explaining initial adoption. On the other hand, factors contributing to continued adoption are access to land ownership and realization of cost-reduction through the program.

Keywords: Q-GAP, certification, rice production, adoption

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Chapter 1

Introduction

1.1. Background of the study

Concerns for food safety at the international level came as a result of reports of foodborne disease that has caused millions to become ill and thousands who died from it according to the World Health Organization (WHO, 2012) while some of these diseases could have been prevented. Working closely with the Food and Agriculture Organization as well as the World Organization for Animal Health and other organizations at the international level, the food safety initiatives address food safety issues from production to consumption (value chain). The institutional framework on food safety came from the 1986 Uruguay Round, under the World Trade Organization, to reform food policies and agricultural trade rules and promotes farm support policies characterized by “carrots” and “sticks” measures (Josling, 2006). In some ways, these frameworks will have an effect on the domestic food policies where national governments are still playing a major role. In addition, organization like the FAO has conventions related to use of pesticides and hazardous wastes namely the Basel, Rotterdam, and Safety and Health in Agriculture, and the Stockholm convention. These conventions help regulate the production and use of chemical pesticides and also for workers handling these chemicals (FAO, n.d.).

Furthermore, at the national level, countries such as the United States, Japan, and the European Union have established programs, regulations, or standards for imported agricultural products in terms of quality, environmental standards, food safety, and phytosanitary. For exporters in the developing countries to export their products to the international markets, they must ensure that products are up to these standards. And, consumers themselves are showing concerns about their health, the product country of origin, and the quality of the products they consume (Liu , 2007).

As the international trade on food products begins to open, the effects on developing countries (producers of agricultural products) will need to be made clear. Some scholars argued that the traditional trade barriers are diminishing and being replaced with new barriers such as safety standards, regulations related to traceability, product certification, environmental standards and other regulations (Frohberg, Grote, & Winter, 2006). Thai scholars have also called these food safety standards, environmental standards, pollution control standards, and others as ‘non-tariff trade barriers’ and a way for developed countries such as the US and Europe to use it in trade negotiations based on technical matters (Nathabuth, 2009) (Sathayakul, 2009) (Boonprakom, 2009). In a way, this demonstrates the forces of economic globalization in which international framework is having a direct effect on the operations within the national sphere.

Classifications of standards varied, some are technical regulations and controls for importing or voluntary certification. For the former, it is the importing countries that establish the regulation, which is a must for business that targets certain country markets, while the latter is a voluntary measure and promotes good practices for businesses that participate in the program.

An example of a voluntary certification for food safety and good practice is the GAP or Good Agricultural Practices, which is not compulsory and businesses that adopts the certification are responsible for economic consequences (Liu P. , 2007). The adopters must also pay for an auditing fee annually to a third-party auditor. However, the adopters could gain better market access, protection of local resources, improvement of workers' health and living conditions of rural communities as a result. The 'good' practices can range from environmental, economic and social sustainability practices for on-farm processes and results in safe and quality food and non-food agricultural products. For instance, the EurepGap was started in 1990s, based on the idea of GAP, when organic agriculture emerged as an option and appealed to consumers' demand. It started with certifying fruits and vegetables, followed by flower and ornamentals, oil palm, coffee, aquaculture, and livestock. In 2008, the GAP idea spread all over the world and the EurepGap was changed into GlobalGAP, owned by European wholesalers, where each country could benchmark against the GlobalGap to attain the same standards so that there is 'one' standard common to all. It is a business to business label rather than directly to customers.

It was mentioned in the seminar "Adopting ThaiGap Adopting Standards, Have Market Access" on May 25, 2012 by the vice chairman of the ThaiGap that in 2003, Thailand exported products that were contaminated with pollutants and this issue intensified seriously overtime. Therefore, the ThaiGap, a private certification provider, aimed to provide standards with access to European markets with an auditing charged fees of 5,000 baht per year for the ordinary (reduced some conditions) and 10,000 baht per year for the premium certification. However, other scholars from the green socialist perspectives mentioned that the private standardization have excluded the "small-scale" farmers from the high cost of investment as well as a support to only business elites in the North, thereby increasing the inequality further (Amekawa, 2010).

The international framework has an influence on domestic policies in Thailand. Apart from the main policy for Thailand agriculture to produce rice for self-sufficiency for domestic consumption and for surpluses to be exported to earn foreign exchange, the new concerns for food safety standards, prompted the government's new policy to "ensure strict food safety monitoring and control system in the country by focusing on food production and processing throughout the food chain" (Supaphol, 2010, p. 40). The ACFS or National Bureu of Agricultural Commodity and Food Standards was established as an organization responsible for implementing the regulatory framework and standard developments according to international standards. This organization developed standards for production, processing, labelling, and product sale of organic product, which is similar to the CODEX and IFOAM standards. This demonstrates that Thailand is aware and recognize the importance of the global trend towards improving its competitiveness in the world market area, otherwise its economy will be damaged. The Agricultural Standards Act B.E. 2551 (2008) had recognized the two tpes of standards: mandatory and voluntary. The Q-GAP is the government's voluntary standard implemented by ACFS (Supaphol, 2010).

As rice is among the major agricultural export product from Thailand according to the Office of Permanent Secretary, Ministry of Commerce, database, it is important that rice production falls into food safety policies. Therefore, Q-Gap specific for rice was initiated in 2004 to start promoting good agricultural practice for rice at the farm level, which include not only large-scale farmers, but also small-scale rice farmers. According to an agriculture specialist from the Department of Rice, Q-Gap for rice has been promoted in 71 provinces throughout Thailand (Department, 2012). Adopters of Q-Gap for rice must apply for registration of their plots for an annual audit and follow the practices provided by the guideline.

In order to achieve sustainability of on farm operation for food safety issue, the food safety agreement should not only contributes only to social dimensions, but should also taking into account of the environmental, social, and economic sustainability of on-farm level operation. A small link exists between food safety practices and having more sustainable environmental practices for instance through the reduction of chemical pesticides or choosing safer pesticides, which contributes to reduced negative environmental effects. Since it is the small-scale farmers who may lose out from this market opportunity as international certification seems to cater towards businesses and operations that are ready to invest and is not responsible for economic consequences, there is a potential that small-scale farmers will lose the benefit as changing their farm management from reducing chemical fertilizer, better water management practices, or using optimal land resources all contributes to "risk" taking and changing of behavior.

Consequently, to prepare small rice farmers to the changing world, other key environmental, social, and economic factors that plays a role in rice farmers' decisions to adopt, non-adoption, or stop adopting (disadopt) standards and certification should be carefully studied to ensure that small-scale farmers do not lose out. Therefore, this study will identify the pattern of adoption, non-adoption, and disadoption of Q-Gap certification among small-scale rice farmers at the farm level. This will also demonstrates the trend of adoption and disadoption, whether it is increasing or decreasing. It will also show the profiles of farmers who decided or denied to adopt the Q-Gap certification. And, to see the linkages of environmental, social, and economic factors that could influence how small-scale farmers participate in the Q-Gap program.

1.2. Statement of the research problem

The challenges at the micro-scale are that not all rice farmers can afford to certify annually with foreign or private voluntary certification because it is an investment that does not guarantee the outcome, making behavioral changes difficult. However, Thailand national policy promotes food safety and health (from kitchen to the table) and tries to steer small-scale farmers to this direction; the voluntary Q-Gap certification is one way in which rice-farmers can participate in this change as it is free of charge (see appendix I for Q-Gap guideline).

Currently, the benefits farmers could receive after completing the program is still unclear. The government cannot guarantee the price difference between rice produced within Q-Gap guideline and rice produced with conventional technique (Srisaket Agriculture Office, 2007), which leaves the farmers to find market access or venues themselves unlike the Thai-Gap that has direct link with the European Union wholesalers through their benchmark or the famous free-trade organization that offers certification for organic products that also has market access already. Thai small-scale rice farmers gives high importance to price as a guarantee and incentives to participate in the program as well as ready market access and the price for GAP should be higher than traditional cultivation (Srisaket Agriculture Office, 2007). On another perspective, according to a personal communication with one of the official from the Department of Rice, there are a total of about 40,000 rice farmers who had received Q-Gap rice certification mostly concentrated in Roi Et, Surin and Yasothorn Province. The number of adopters and rice farmers who applies for a certification varied form province to province and from variety of rice. For example, available online database on rice farmers and Q-Gap rice certification in 2009 suggests that in that year many farmers passed the Q-Gap registration, except for some central region such as from Nakhon Sawan, Chainat, and Singburi province and some northern provinces.

The Q-Gap rice certification is supposed to link the on-farm operation of rice farmers' best management to fulfill the food safety and environmental policy at the national and international level. However, with no incentives for farmers in terms of guaranteed price, it is interesting that the data provided by the government had shown otherwise. There are rice farmers who register for Q-Gap certification, passed and failed to pass. This contrasted information mentioned above between incentives and farmers' participation give rise to other questions regarding the pattern of their participation and other social, economic, and environmental factors that might play a role other than guaranteed price.

1.3. Rationale

Food safety as a health and social issue is one of the pillars for sustainable agriculture (see figure 1.1). As domestic and international policies are moving towards food safety, the issue is almost always interlinked to other sustainability issues such as environmental effects and economic viability. Achieving sustainability of agricultural production is an ideal framework that includes not only food safety, but other issues as well. Promoting only food safety issue to rice farmers without bringing any other concrete economic (cost-savings) and social benefits (improved health of farmers themselves) will not win the hearts of the major small-scale rice farmers who may still enjoy the benefits from the wealth of natural resources such as soil and water until certain catastrophe (eutrophication, cancer disease, reduced sales or other health issue) befall upon them.

Research have come up with key social, environmental, and economic factors that contributes to organic rice certification in Thailand and other countries, but in terms of the Q-Gap certification for food safety (free of charge), there is still little clear understanding of these factors and how they play a role in the adoption and disadoption pattern. Most of the literature in Thai language emphasizes environmental factors that contribute to the success or failure to pass the Q-Gap certification mostly in the Northeast region (Nathabuth, 2009) (Boonprakom, 2009) (Sathayakul, 2009). This is only one of the sustainability dimensions. Meanwhile, other research that includes social and economic factors as well as motivation investigation of rice farmers who adopted organic rice certification did not further explored rice farmers that discontinue to apply for the certification in the Northeast region (Pornpratansombat et al., 2011). As for the central region, a location for irrigated rice fields where rice is cultivated more than 2 times per year (high productivity), there seems not be research in this area. This research aims to continue this exploration based on recent literature the various environmental, social, and economic factors that influence the pattern of adopting Q-Gap rice certification for the central region.

Finding out the key significant social, environmental and economic factors from rice farmers who adopted or disadopted will help policy-makers to build capacity of small-scale rice farmers or take actions appropriately. The strong and weak points could be further categorized where training, knowledge improvements, economic incentive programs, or other initiatives for rice farmers could be utilized to prepare Thai rice farmers in the future world.

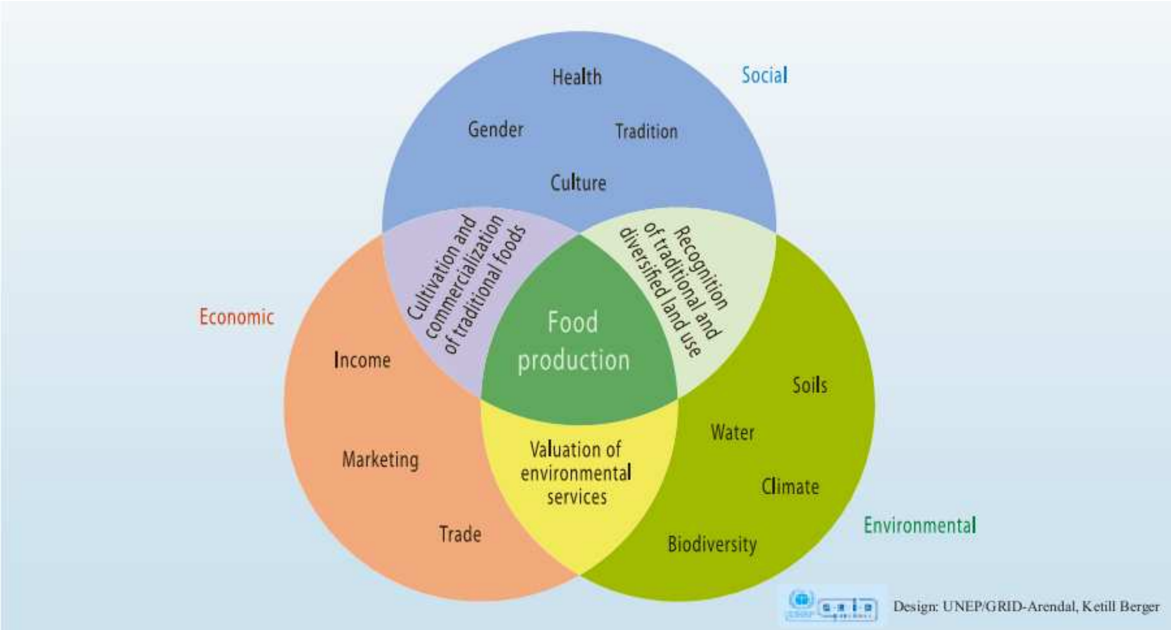

Figure 1.1 Environment, social, and economic pillars of food production (IAASTD, n.d.)

1.4. Objectives

The main research objective is to profile the environmental, social, and economic factors and to identify the significant factors that contribute to the adoption, non-adoption, and disadotpion of the Q-Gap rice certification in the central region of Thailand.

The specific objectives are:

1. To identify the patterns of Q-GAP adoption of Thai rice farmers in the Central Region

    Research question 1: Are adoption linked to some identifiable factors?

    Research question 2: What is the extent of disadoption?

    Research question 3: Is disadoption linked to identifiable factors?

2. To understand how rice farmers participate in the Q-Gap certification

    Research question 1: do they have separate on farm management regarding use of pesticide, herbicide, and fertilizer?

1.5. Scope

There are various types of rice field or rice cultivating system in Thailand: irrigated or rain-fed. The survey will be conducted in the central region where there is the highest yield and productivity compared with other region of rice cultivation. It is also where most rice farmers use herbicide, pesticide, and chemical fertilizer to increase their yield and productivity. The research for rice Q-GAP could be done in the central region where it can have the most impact.

Also many types of certification are available from different agencies such as ACFS, ThaiGap, USDA, Q-Gap or fair trade. However, this study will only consider the Q-Gap certification offered by the Thai government for rice commodity only. This research only targets rice farmers participating in Q-Gap rice certification only and will not take into account rice farmers who has more than one certification.

The scope is based on the key social, environmental, and economic factors based on literature review. The research utilizes mainly quantitative approach with some qualitative approach in some questions in the questionnaire, observations, and literature review to support further analysis and identifying key points.

Participation in this research can be defined as the farmers' decision taken to register for certification or not, the success or failure to pass the certification guideline including their decision to continue or discontinue the certification registration.

Adoption in this research can be defined as the participating actions of rice farmers in the Q-Gap certification program and the successful registration of Q-Gap rice certification (meaning the rice farmer has passed through all the guidelines).

Disadoption in this research can be defined as the decision of the rice farmer to discontinue or exit their participation in the program. This applies only to farmers who have passed the registration successfully. They can discontinue along the way or year by year.

1.6. Limitations of the study

The limitation of the study is that it does not answer the changes of behaviour of farmer based on their interests and motivations through time (dynamic). It does not try to understand the psychological factors. It can only compare the characteristics of different types of farmer groups or population and their perceptions of the program, which stems from limiting financial and time resources.

The timing of rice cultivation and field research was planned carefully. Rice farmers in the central region may take part-time jobs in the urban area and leave their field, so the field survey was done when farmers are available at the field or when they are developing land, transplating, cultivating, post-harvest, or when they are applying fertilizer or chemical pesticide.

Farmers may feel uncomfortable sharing their personal information such as income, plot size, or secondary income activities and may not share all personal information. They may even feel embarrassed for example for not following good environmental practices. Questionnaire was geared towards asking indirect questions and flexible.

Farmers may feel uncomfortable sharing information if local government officer is present at the time of the interview. The interview was as neutral as much as possible.

Chapter 2

Literature Review

This research aims to identify the factors affecting the adoption or disadoption of Q-Gap rice certification in the central region of Thailand and comparison of on-farm management, literature reviews were mainly focusing on the overview of the framework in technology adoption, former research on technology adoption for rice sustainability production from other places not in Thailand, and specific documents related to Q-Gap adoption in Thailand. Methodology for evaluating adoption and disadoption is also mentioned.

2.1. Technology adoption

Theory on agriculture technology adoption and non-adoption came out during the 1950s and continues to the present day with evolving frameworks and methodologies. It is crucial to first define technology adoption and aggregate adoption from the literature, and also discusses the idea of disadoption of technology. Second, the framework used to study technology adoption is discussed as well as some of its challenges from the past and explore the changes of current research from the past.

2.1.1. Defining adoption, aggregate adoption, non-adoption, and disasdoption

Economists like Georg M. Beal and Joe M. Bohlen in the US initiated the research on agriculture technology adoption in the 1950s (Bohlen & Beal, 1957). Later works by Rogers (1962) studied the adoption process in relation to innovations and have defined adoption as “the decision to make the full use of an innovation as the best course of action available,” rejection as “a decision not to adopt”, and discontinuance as “a decision to reject an innovation after it had been previously adopted” (Rogers, 1962, p. 21). Others further developed the definition of adoption as measured by the degree of use of a new technology in the long-run equilibrium with farmers’ full information about the new technology and its potential (Feder, Just, & Zilberman, 1985). With this definition, two things comes into play, one is there seems to be a degree of adoption (low or high), which can be measured quantitatively, while the other is the state of equilibrium where farmers could reach, which he/she would use the same technology introduced for a long time.
Other authors argued that technology is always changing and farmers may adopt a technology and later reject it when they find other improved technology available, this is related to the process of technology diffusion. This is where aggregate adoption is defined as the process of spread of a new technology within a region within a given geographical area or a given population (Feder et al., 1985, p. 257).

These definitions reflect the two approaches used to explain the phenomenon of technologies adoption summarized by Diederen et al. (2003). The first is called the epidemic diffusion model, which emphasize process of diffusion as a disequilibrium process. It assumes that there is information about the existence of the innovation, but with uncertainties on operating conditions, risks and performance characteristics of the new technology makes adoption unrealizable. On the other hand, the decision-theoretic approach regards diffusion process as equilibrium. It explains that gradual innovation diffusion is not due to market imperfection, but to the benefits of the new technology on the potential adopters’ structural characteristics. These characteristics include firm size, market share, market structure, R&D expenditures, input prices, labour relations, firm ownership, and current technology. The probit model is the main empirical model that relates innovation diffusion to variation in characteristics and in benefits.

Current study of adoption such as by Jones (2005) on adoption of soybeans and (Liu et al., 2011) on sustainable agricultural technologies have used the same definition of adoption but expanded it to include 'choices' of technologies, not just for one new technology. Other current adoption and disadoption research still maintains the above-mentioned definition.

2.1.2. Models of adoption

Most of the earlier works on new technology adoption seems to use a more static model in which authors relates the degree of adoption to the factors affecting it. These static models were assuming that farmers must decide and use one modern technology and the extent of adopting it (Feder et al., 1985). An example is, from one of the earlier research was in 1957 by George M. Beal and Joe M. Bohlen, where the authors had tried to find how farmers accept new ideas. The research from corn growers in the US steered the authors to develop the framework on agriculture technology adoption into five stages of 'diffusion'. The first stage is the awareness stage and it is when an individual becomes aware of the idea, the idea exists in his/her mind, but still lacks detailed information. Second, the interest stage is when the individual takes the initiative to learn more about what it is and how it works and what the potentials are. In the third stage, the evaluation stage is when the farmer compiles information from the previous stage and applies to his/her own context for decision-making (evaluating the cost and benefits from adoption). At the fourth stage, the individual decides that the technology could work and then experiment with it. And finally, the adoption stage is characterized by large-scale, continued use of the idea, and also is satisfied with the idea. Individuals may go through different stages at different rates.

In later works during the 1970s and 1980s, some work was using Bayesian model to explain how producers improve their prior beliefs and tends to increase the share of the modern technology over time (Feder et al., 1985). It allows for a more detailed investigation of adoption path and evaluates better the adoption process before final adoption, which accounts for the time lag before final adoption where producers uses the technology in the long-run. Limitations to some of the works under this model is that it assumes risk neutrality, so later works have added risk factor, where lower risks contributes to shorter time lag before final adoption.

Other models account for the aggregate adoption, which is a more dynamic model that shows the diffusion process over time. One model is usually in the S-shaped curve or sigmoid curve. Most works in this model assumes communication as the major driving force of contribution in diffusion process. A second model is 'technological treadmill' as another approach to investigating diffusion process. As people adopt technology at different rates, Rogers (1962) divides people into groups of types of adopters: innovators, early adopters, early majority, late majority, and laggards. Recent research still uses this model such as Lapple & Van Rensburg (2011) that provided details about the different groups of organic adopters in terms of time of adoption. They have identified the characteristics distinction for decision-making for conversion for early, medium, and late adopters. The results shows that in terms of farming intensity, age, information gathering and attitudes of the farmer play a significant role in conversion decision-making. The early adopters were usually the youngest and their decisions are not based on profit making. As for the late adopters, risks considerations were major constraints. However, environmental attitudes and social learning were important determinant for all groups.

Table 2.1 Type of adopters and their characteristics (Rogers 1962)

Type of adopters	Characteristics
Innovators	Large farm; high status; active in community; extra-community contacts (formal and informal); information (college-direct or agencies); not named as source of information by other farmers
Early adopters	Younger; higher education; more formal participation; more co-op and government agency and programs; more papers, magazines, and bulletins;
Early majority	Slightly above average (age, education farming experience); medium high socio-economic status; more papers, magazines, and bulletins; attend more agricultural meetings; earlier and more adoptions than majority; usually not innovators; informal leaders
Majority	Less education; older; less social participation; less co-op and government agency programs; fewer papers, magazines, and bulletins
Non-adopters	Less education; older; less social participation; less co-op and government agency programs; fewer papers, magazines, and bulletins

Yet, another model called "cautious optimization" by Day and Singh (1977) as mentioned in Feder et al. (1985) assumes that farmers' constraints due to risk aversion is removed through learning by doing and financial constraints are relaxed from the buildup of surplus generated by the profitable adoption in the previous years. All these models mentioned have assumed that there is a controlled amount of land and with no information on land ownership or rental arrangements. Some conclusions from the 1970s and 1980s research found that sharecropping could hinder adoption of innovations and tenants attitudes depends on the riskiness of the technology and profitability (Feder, Just, & Zilberman, 1985).

The introduction of the Green Revolution in the 1980s aimed to solve food security issue by using technologies and innovations to improve efficiency so that the same amount of land will produce more food through the use of fertilizers, machinery, irrigation techniques, or pesticides, which is the intensification of land use. Instead of farming twice a year, farmers can now farm four times a year with new technologies such as GMO crops, fertilizers, hybrid crops, water diversion, dam construction, and other techniques. Much of technology adoption research was surrounded by this movement, which some of the major factors found could still play a role today. As we approach the 21st century, more research shifted focus to technology adoption of sustainable agriculture, organic agriculture, natural system agriculture, and other types of agriculture that are environmentally friendly, low-inputs, safe for consumers and producers, and other topics which will be discussed later on.

2.1.3. Models of disadoption

Though mentioned above on the definition of disadoption as the discontinuance of the technology by the farmer in the 1950s, most research in the past has been concentrating on the adoption or non-adoption of technology rather than identifying the factors that steers a farmer towards an exit of the technology. Studies that concern both adoption and disadoption process seems to use a more dynamic approach taking time into consideration. An example of this is by the case study of SRI or System of Rice Intensification in

Madagascar that gives high yields with low-input technology (Moser & Barrett, 2006). The adoption rates has been low for this technology so the aim of the study was to use a probit model and dynamic model to analyze the decision to adopt, expand, and disadopt the method. The disadopt factor uses a dummy variable for 'continue', if farmer continues, then it is given as 1 value and if farmers stops, then it is given as 0 value. While, in another study on organic farming adoption and disadoption in Ireland, accepts that there is a considerable amount of literature on adoption, while little literature was focusing on abandonment or exit decisions of organic farming. The author have used duration analysis, similar to the former study, that takes into account of the time factor and making the research much more dynamic.

2.1.4. Social, economic, and environmental factors for adopting new technology during the Green Revolution movement

Empirical investigations literature during the Green Revolution movement into factors influencing farmer's decision to adopt new technologies (high yielding varieties) varies in terms of the relationships patterns of key factors on adoption behaviour are summarized in the work of Feder et al. (1985). It is useful to mention as these works laid the basis for thinking about the factors and behaviour of farmers. It should be noted that the technology adopted is divisible, meaning farmers can choose to adopt just one technology (no packages of technology needed). Also, there is no credits given and tenure constraints. Some of the key factors include farm size, risk and uncertainty, human capital, labour availability, credit constraint, and tenure.
It has been confirmed that larger fixed costs reduce the tendency to adopt and lowers the rate of adoption by smaller farmers, unless there is an effect of hired services (hired tractor services, seed services). Large farms may have more capital, so they are ready to invest without credit constraints, therefore a higher rate of adoption. Fixed costs could include learning, locating and developing markets, and training hired labour, which if considered by small farmers, they are less likely to adopt. In terms of fertilizer and pesticide use per unit of land, it depends on the risk preferences of farms and on the risks effects of the inputs. The size of holding could imply other factors at play such as access to credit, capacity to bear risks, access to scarce inputs, wealth, or access to information. This means that there are several factors that determine the observed farm-size and adoption relationship.

Risks and uncertainty comes with new technology adoption in the form of subjective (uncertain yield) or objective (weather variations, pests, uncertain time for inputs) risks. Based on research, it seems that this factor depends on farmers' perception of risks, which implies the importance of access or exposure to information and new technology. Sources of information that have been researched includes mass media (newspapers, radio, leaflets), literacy, level of education, visitation of extension official and period of time spent out in the village.

Literature on human capital and technology adoption dates back to the 1970s where first investigation was on improvement of farmers' entrepreneurial ability in allocative ability and change of technological environment. Allocative ability is a learned ability to reallocate resources in response to changing conditions (Huffman, 1977 as mentioned in Feder et al., 1985). Later works suggested education and extension services as a factor in improving allocative ability of farm operators and how they adjust to changes in price.

Overall, farmers with better education seem to be the earlier adopters of modern technologies and apply modern inputs more efficiently throughout the adoption process.

Labour availability is another variable that affects farmers' decision to adopt new technology or inputs as some of these new techniques are labour saving or labour using. In times of labour shortages, a new technology that saves labour is well adopted.

Different rates of adoption could be as a result of credits constraints or availability or access to credits. Some of the new technology may require large fixed costs. But, others argues that credit availability may not be the pre-determined condition as some farmers have proven that profitability from high yield varieties (HYVs) could act as an incentive for farmers to find and mobilize even the smallest cash requirements for necessary inputs. Off-farm income is also an important factor to alleviate capital constraints and allow farmers to invest in fixed investment.

Tenure arrangements have been researched in the literature. Some studies suggest that tenants had a lower tendency to adopt HYVs than owners, while fertilizer use was similar. Some studies have a confusing relationship between tenure and adoption, and some suggests that tenants should be made clear: pure tenants (who own no land) and tenant-owners (who own at least some of their land). It is the tenant-owners who seem to be more inclined towards innovation adoption as they have less credit constraints. Others observed that there is an implied relationship between tenure and access to credit, input markets, product markets, and technical information.

And, supply constraints can explain the adoption pattern as some new technology may have complementary inputs (seeds come with fertilizer). Complementary effects may needs to be considered.

2.1.5. Sustainable agriculture and organic agriculture technology adoption

In the new 21st century, much concern has been raised on sustainable development in agriculture. This concerns came as a result of the realization that land is a limited resource, challenges of food production to feed the world's population is still pressing, but the use of high yielding varieties, unsustainable agriculture practices during the Green Revolution puts pressures on land resources and other natural resources such as the heavy use of soil and the eutrophication of lakes and coastal areas from agricultural run-offs, which cause environmental pollution and degradation that is expensive to reverse as well as causing negative health impacts to the farmers themselves (GEO 4, 2007).
The investigation of new technology adoption for sustainable agriculture and organic agriculture continues. Current research on agriculture technology adoption research range varied by technology and investigated variables. Diederen et al. (2003) have used the framework proposed by Beal and Bohlen and tested for the Dutch farmers' choice of innovation adoption in agriculture available in the market using nested logit model. They have found that structural characteristics: farm size, market position, solvency, and age of the farmer are the significant variables that explain innovators and early adopters and laggards. This shows that the model developed previously is still in use today.

For adoption of sustainable agriculture adoption in Shangdong Province, China, Liu (2011) investigated the overall level of farmers' adoption in the province on 10 sustainable technologies promoted by the government. It was found that the level of adoption was low in the area and pointed to several causes such as small-scale agricultural production, insufficient market demand for eco-agricultural products, inadequate agricultural technology extension efforts, and low educational level. One can see that some of the factors used in the past have been applied again. This research focused on one new technology rather as a packaged technology and it did not consider complementary effects.

Other authors Lestrelin, et al. (2011) investigated conservation agriculture (CA) as alternatives to agricultural tillage in Laos on a micro scale. This approach divided farmers into four groups as farmers who practiced tillage-based agriculture or shifting cultivation and had never used CA; members of CA farmer groups; farmers who practiced CA but were not members of a farmer group; and farmers who had experimented with CA but had later reverted to tillage-based agriculture. The research used statistical analysis of different datasets including household capital assets, labor, age, education level, rainfed land tenure and the extend of direct seeding mulch-based cropping (no tillage, permanent plant cover, and adapted crop associations and rotations). And, a factor analysis was used to identify relations between location of the farm and the extent of DMC use on the land. The results show variations in adoption rates across the region. While farm level variables such as capital, labour, age, and education show no significance, access to land helps shape local-decision making and experience and awareness of land degradation, production costs, social cohesion and leadership appears to be key factors in local adoption rates.

The three examples shown above have no mentioning of disadoption or discontinuance of the new technology. In another study, however, Yamamota & Tan-Cruz, 2007; Moser and Barrett (2006) explore the dynamics of smallholder technology adoption of a high yielding, low external input rice production method in Madagascar using probit model. They have analyzed the decision to adopt, expand, and disadopt the method. It was found that seasonal liquidity constraints was discouraging farmers to adopt the method, while learning from extension agents, and from other farmers influenced the decision to adopt.

As sustainable agriculture seems to be more about reduction of pesticides or chemical fertilizer use, quality improvements, food safety, and to safeguard natural resources, organic agriculture seems to be at the extreme. On the other hand, organic agriculture is defined as the production of crops without the use of inorganic inputs (such as chemical fertilizer and pesticides). Fertilizer is derived from organic material such as animal manure, green manure, and compost. No synthetic or artificial chemical pesticides and fertilizers. Soil fertility is maintained through natural processes and crops are rotated in fields; and the use of alternate pest control management.

Lapple and Rensburg (2011) provide details about the different groups of organic adopters in terms of time of adoption in Ireland. They have identified the characteristics distinction for decision-making for conversion for early, medium, and late adopters. The results shows that in terms of farming intensity, age, information gathering and attitudes of the farmer play a significant role in conversion decision-making. The early adopters were usually the youngest and their decisions are not based on profit making. As for the late adopters, risks considerations were major constraints. However, environmental attitudes and social learning were important determinant for all groups.

In another research in the Philippines on organic rice farming adoption, Yamota and Tan-Cruz (2007) found that age, number of years in formal schooling, number of seminars attended, number of household members involved in farming, farmers' valuation, and tenure were positively related towards the rate of organic adoption. This research reflects the theoretical basis that communication factor and information is an important part in technology adoption.

Other authors such as Pornpratansombat et al. (2011) did not directly use the framework provided by Beal and Bohlen, but have the factors affecting the adoption and diffusion of organic farming through using descriptive statistics. Water accessibility, farm-gate price and attitude to conventional production problems were identified as the major factor for decision-making. For attitude towards rice farming, farmers strongly support specialized markets and premium prices for organic food and special credit (on inputs) should be given to organic farming. Farmers disagreed on low-yield of organic rice farming. The first conclusion to this study is that organic farms depend more on agricultural activities income more than conventional farms, which may get off-farm income. Many farmers who switched to organic farming are those who faced problems arisen from conventional farming. This study is interesting in itself because it shows that people who switched completely to organic rice cultivation are those who face problems from conventional farming. However, this research does not explore disadoption rate of organic rice cultivation nor divide groups of farmers into early, medium, and late adopters which would also be good as to confirm that farmers who adopted the technology continues to do so. In a way this is not a dynamic research.

Other than socio-economic factors, research on the opinions and attitudes were also investigated such as the comparison on four aspects: organic farming knowledge, environment, marketing, and costs and benefits in Northeast of Thailand (Surin province) between organic farming and conventional farming by Chouichom & Yamao (2010). First, it was found that higher education experience and longer farm experiences supports the switch. Second, it was found that farming costs were associated with decision-making. In general, the opinion of organic farmers to organic farming is favorable, while conventional farmers seem to be unclear about organic farming. However, this research is not clear whether the farmers interviewed were associated with certification or standards and they were not divided into early, medium, or late adopters making it more or a less a static type of research.

Direct marketing strategy adoption were also investigated by Detre et al. (2011) to identify the factors for adoption on organic producers in the US using a double-hurdle approach. They have found that production of organic crops and the regional location of the farm is positively affect the adoption, while negative relation was due to large farm size, farm with production contracts, and farms specializing in cash grains.

Specific technology adoption research is in the North of Thailand by Angasith , Na Lampang, Apichatphongchai, & Intrakkhamporn (2005) that investigated the factors affecting rice technology adoption of farmers participating in occupation development projects in large-scale irrigation system improvement area. It was found that in Chiang Rai Province, farm size, land rented, farm income, indebtedness, irrigation system received from the project, and frequency of attending from forum were positively related to rice technology adoption, while in Phayao Province, land rented, number of documents distributed by the project, frequency of attending farm forum, and farmers opinion to the role of the project positively affected adoption.

In a recent review and synthesis of research by Knowler & Bradshaw (2007) on farmers' adoption of conservation agriculture, a total of 31 technology analyses for conservation agriculture from 21 research studies were investigated to find influencing factors that play a role in adoption of 'no tillage' or conservation tillage. The study points to one interesting note that each location studied is quite context specific, and so a universal factors that influence adoption cannot really be found. Often used factors such as attitudes towards conservation, education, age, and experience is still being debated whether or not it has positive, negative, or insignificant influence. As for biophysical characteristics factors, the usual hypothesis regarding farm size is still inconclusive, while it was found that farmer awareness of, and concern for, soil erosion is probably a more critical factor. This is also related to the usual belief that tenure system will have an impact on farmers' improved maintenance of soil, but this is not always so. Furthermore, even labour management and farm income shows no clear positive influence. Though, it was mentioned that participation in state subsidy or in contact with extension officers by the study, it does not mean that the adoption occurs continuously. This research has a limitation in that it focuses on the adoption studies.

2.2. Q-Gap adoption research in Thailand

Recalling that Q-Gap rice certification stated in 2004, ever since, there has been research and evaluation studies on its success and failures mostly in the Northeast region or rain-fed area. The Surin Rice Research Center had initiated a research conducted by Nathabuth (2009) in Roiet and Surin provinces to identify the factors that influences the failures for rice farmers to pass the Q-Gap rice certification. They have found that with natural disaster such as drought, flood and intermittent rain were causing farmers to fail the certification. Also, farmers did not have bookkeeping or records kept or it was lost, rice with low quality and does not accord with the guidelines, and other factors (e.g. use of prohibited pesticide). It was found that about 82% of farmers passed the auditing process for Surin province, while 71% passes for Roiet province from a total of 5,198 sampled plots.
In another report by the Ubon Ratchathani Province Research Center, a research was conducted by Sathayakul (2009) that investigated rice farmers in Ubol Ratchathani, Amnatcharoen, and Yasothorn provinces. It was found that out of a total of 3,227 plots, 61.8% passed the certification. About 47.3% of plots that did not pass faces problems with rice quality or has too much off type rice. As for natural disaster, about 52.5 % were affected with drought, too much weed, and seed problem.

Another study by Noonui (2004), investigated the factors related to practicing Gap rice of 101 rice farmers in Warinchamrab District, Ubolratchathani province. The author researched social and economic situations of rice farmers participating in GAP; physical environment of rice GAP area; farmers' attitudes and motivation toward rice GAP; farmers' adherence to the rice GAP; factors related to it; and problems and recommendations for rice GAP. As a result of the research, family members, number of labor, total farming area, total rice farming area, total agricultural income, total income, farmers' attitude and motivation were significant.

In Udornthani and Nhongbualamphu provinces, Boonprakom (2009) investigated a total of 580 plots and about 58.79% of plots passed the auditing process. Others experienced problems with drought as a natural disaster and problems related to the guideline: use of hazardous substances, rice was not cultivated according to the said species, management of rice production for no less than 40% of rice plant, and bookkeeping and records.

In Yasothorn province, Kamma (2007) investigated a total of 9,070 that registered for the Q-Gap rice certification. About 40% passed the auditing, while others faced with off-type rice (low quality) and weeds in the paddy more than standards, natural disasters (flood and drought), and problems with bookkeeping and records.

And the Office of Agriculture Sri Saket Province conducted a study on Hom Mali Rice and rice GAP certification. A total of 1000 rice farmers who participated in the program and 1,023 rice farmers who chose not to participate in the program were surveyed for GAP management in the plot, yield, profits, and satisfaction of farmers as well as attitudes to understand the effectiveness of safe Hom Mali rice that passed GAP certification. In terms of GAP management in the plot, rice farmers were able to follow quality criteria for more than 90%; for water management 80%; and for bookkeeping 68.56%. For the satisfaction dimension of GAP criteria, rice farmers were satisfied at the average level or 48.62% of those who participated. Satisfaction includes satisfaction for yield of Hom Mali rice, level of production, and more income from GAP. Other factors include conditions before and after participating in the program, indebtedness, and savings. As for incentives to participate in the program, it includes: private sector promoting it; government promotion; desire to participate in environment friendly initiatives; expected profits; market demand; and neighbor involvement in project.

About 86.22% of rice farmers passed the certification. As for input cost, participated farmers has an input cost of 1,438 baht/rai (land preparation, seed, transplanting, fertilizer, harvest), which is lower than farmers who did not participate with 43 baht difference/rai. The yield for participated farmers (436.01 kg/rai) is a little higher than those who did not participate at 0.33% (438.43 kg/rai). And as for profits, those participated received 8.39 baht/kg for Hom Mali rice, which is similar to those who did not participate at 8.35 baht/kg. This means participated rice farmers earn 3,658 baht/rai and for those who does not participate at 3,661 baht/rai. It was found that participated farmers consume their own produce at 32.96%, sold to brokers 25.09%, sold to millers at 23%, and others (sold in community or bartering for other commodity) at 12.30%.

The research suggests that government should solve pricing issue clearly such as guaranteed price for rice GAP so that Hom Mali rice price would be higher as well as more government officials to audit plots and price incentives to encourage famers. Farmers thinks that there should be government representatives giving advice and demonstrates different techniques for effectiveness of the program (faster diffusion), knowledge from training and increasing budget to support this, and to have container with logo for GAP for separation from other type of rice. It is believed that price is an important factor and there should be clear measure to promote confidence of participated farmers and as a incentive for those who did not join. Market for GAP should also be encouraged with GAP price higher than other rice that is guaranteed.

More complicated research design is done on fruits and vegetables that received Q-GAP certification have been done in the North region of Thailand by (Schreinemachers, et al. (2012). Since Q-GAP standards focuses on food safety by promoting the reduction and appropriate use of pesticide, the research tried to find whether or not Q-GAP adopters really did reduce the input use. It was found that this was not the case and that some adopters of Q-GAP have actually used more input use than non-adopters. As described by the author, the standard seemed to be relaxed and some farmers can get away with some standards. Some problems were mentioned such that Q-GAP program did not give alternatives to farmers in terms of pesticide use, some farmers did not get proper training, and the manual for Q-GAP doesn’t address why farmers should reduce pesticide. Based on the research, the author is not sure whether this program is a good policy for improving pesticide management practices.

Though the above mentioned research and reports seemed to be quite negative on Q-GAP program, another research noted the more positive side on Q-GAP adoption. The study compared Q-GAP adopters and GLOBALGAP adopters by investigating factors related to socio-economic characteristics; farm characteristics; access to information, credits, and infrastructure; membership in farmer groups; previous contact with certification initiatives; and assistance and agricultural trainings. Using bivariate probit model, it showed that the Q-GAP more or less could act as a stepping stone towards the GLOBALGAP, which is a private certification with much more complexity (Kersting & Wollni, 2011). It was found that one of the major significant for the success of the GLOBALGAP adoption is the support provided by exporters or downstream stakeholders.

Some of the factors mentioned in studies related specifically to Q-GAP in the context of Thailand have added and changed some variables. It should be noted that rice commodities is a bit different from fruits and vegetables and faces different challenges. Unlike fruits and vegetables, chemical residues or pesticide residues in rice product has not been reported (personal communication: 2012) and the characteristics of cultivating rice uses a lot of water, therefore it is possible that the different type of system makes rice better off in terms of residues. One of the major rice production challenges at the farm-level is seed quality as the Thai government doesn’t have the full capacity to provide seeds for every farmer. Post-harvest quality control is a challenge at the field-level rice production such as problems related to off-type rice (mixing of different types of rice) where farmers must try to keep their produce from having off-type rice below 5% for white rice and 2% for Hom Mali rice or percent of broken kernels must be kept low. Other challenges include water scarcity in some region (Northeast region) and how to keep rice at optimal moisture for sales to the millers. Inappropriate pesticide use is prevalent in the Central region where outbreaks of brown plant hoppers have been a major problem.

2.3. Management of fertilizer, pesticide, and herbicide as recommended by Q-GAP and Department of Rice

As mentioned earlier, Q-GAP certification is trying to promote food safety initiatives in Thailand. The program is also promoting cost-savings, improved rice production quality, and prevention of chemical residues from rice farming operations. High capital for rice production is fertilizer and chemicals for preventing rice insects and natural enemies in rice production, which calls for appropriate application. The Office of Rice Product Development under the Department of Rice, has summarized comprehensive recommendations on rice production management for pesticide, herbicide, fertilizer, water use, land development, transplanting, and harvesting recommendations for cost-reductions of rice farming in Thailand in a booklet prepared for training “Rice Production and Cost Saving” in 2011.

For wet direct seeding, most commonly used technique for rice production, with non-photosensitive lowland rice, it is recommended that herbicide should be sprayed 4 days before seed germination and apply herbicide according to specific weed. For specific type of weeds, there are recommended active ingredients, amount applied as follows:

Table 2.2 Recommended herbicide agrochemicals by Q-GAP program (Ministry of Agriculture and Cooperative Thailand, 2011)

Weed	Active ingredients	Amount/20 liter of water	Remarks
Narrow leave weed, broad leaf weeds, ferns, and cyperaceae weed	Oxadiazon (25% ec) Butachlor/2, 4-D (6.8% G) Pretitalchlor (30% ec)	120-160 milliliter 800-1,000 gram 450-600 gram	
Narrow leave weed, broad leaf weeds, and cyperaceae weed	Propanil /2, 4-D (36% ec) Propanil/thiobencarb (60% ec) Propanil/molinet (66% ec)	220 milliliter 130 milliliter 120 milliliter	
Narrow leave weed, broad leaf weeds, cyperaceae weed, and algae	Thiobencarb (80% ec) Thiobencarb/2, 4-D (7% ec) Oxadiazon/2, 4(16.6% ec)	1,000 milliliter 1,150 gram 180-240 milliliter	
Broad leaf weeds, fern , and cyperaceae weed	Bensulfusal-methyl (10% WT)	20-60 liter	Use after 4-7 days of transplanting or 6-10 days after sowing
Broad leaf weeds and cyperaceae weed	2,4-D (95% sp)	30-30 liter	15-20 after transplanting or sowing

Fertilizer should be applied 3 times for non-photosensitive rice: 1st time 20-25 days after land preparation; 2nd time is after 15-20 days from 1st fertilizer application; and 3rd time is after 15-20 days from 2nd fertilizer application. For clay soil, 16-20-0 should be used and for sandy soil, 16-8-8 formula used be used along with urea (46-0-0). In general, it is recommended that for 16-20-0 and 16-8-8 formula (2 times), 25-30 kg per rai should be used and 46-0-0 (1 time) is 5-10 kg per rai. This means a total of 3 fertilizer applications per season and the N input from this methodology ranged from 860 to 1,400 (from N formula multiply by kilogram).

As for pesticide application, specific agrochemicals are recommended for each pests as shown in table 2.3

Table 2.3 Recommended pesticides by Q-GAP program (Ministry of Agriculture and Cooperative Thailand, 2011)

Pest	Active ingredient	Amount/20 liter of water
Rice thribs	Malathion (malathion 83% ec) Carbaryl (sevin 85% wp)	20 miligram 20 gram
Rice leaffolder	Carbosulfan (pause 20% ec)	80 milliliter

	Fipronil (ascend 5% sc)	50 milliliter
Brown planthopper Whitebacked planthopper	Buprofezin (applaud 50% wp)	10 gram
	Buprofezin (applaud 10% wp)\	25 gram
	Buprofezin/isopocarb (apsin 5%/20% wp)	50 gram
	Etofenprox (trebon 10% ec)	20 milliliter
	Etrofenprox (trebon 5% ec)	40 milliliter
	Etrofenprox (permit 5% ec)	40 milliliter
	Carbosulfan (pause 50 wp)	110 milliliter
	Isopocarb (mipsin 50 wp)	60 gram
Rice stem borers	Chlorpyrifos (lursban 20% ec)	20 milliliter
	Chlorpyrifos (lursban 20% ec)	40 milliliter
	Carbosulfan (oause 20% ec)	80 milliliter
Rice bug	Carbosulfan (pause 20% ec)	80 milliliter
Rice gallmidge	Imidaclopid (confidor 10% sl)	15 milliliter
	Chlorpyrifos (% ec)	40 milliliter

2.4. Methodologies used to analyze adoption or disadoption

Methodologies used to analyze or explain adoption behavior varied from simple methods to complex models. The simple technique to explain the adoption behavior includes the use of simple statistical tools such as percentiles or averages derived from likert scales. Literatures on Q-GAP research in Thailand have relied on these methods. The limitation for these methods is that it analyzes the factors individually, which may not be accountable for other factors that may have an influence on it. For instance, Hossain, Sugimoto, Ueno, & Huque, (2007) used simple statistical analysis such as frequency distribution, cross-tabulations, and chi-square testing to investigate adoption of organic rice for sustainable development in Bangladesh. In another study by Lestrelin (2011), a statistical analysis and factor analysis method was used to identify possible relations. Again, these methods has its limitation in that it doesn't take into account of other

Other than the usual statistical analysis methods, the first econometric study of aggregate adoption over time was by Griliches (1957) as mentioned in Feder, Just, & Zilberman, (1985) that introduced economic variables to explain the diffusion of hybrid corn in the US. It is a sigmoid function with an upper limit, and the differences in the upper limit are explained by differences in profitability of the technology.

Most empirical studies on adoption in the past have categorized variables as adoption or non-adoption, but lacking information on the intensity or level of adoption (whether a farmer is using 1% or 100% in the plot). The methods used to analyze is ordinary regression methods, which regresses explanatory variables on adoption or non-adoption as (zero-one). This is a limitation in itself since it cannot be used to find further details of less than zero or greater than one. Several other studies have used correlation analysis to determine the relationships of several factors on adoption, but this could pose problems if there are other variables influencing the correlation.

Econometric methodology appropriate for dichotomous variables like adoption and non-adoption was developed and commonly used for qualitative response models are the logit model and probit model as it take into account of the qualitative nature of adoption. The two models specify a functional relation between the probability of adoption and various explanatory variables. The logit and probit model was derived from the cumulative distribution function with the sigmoid or S-shaped curve. The logit model corresponds to logistic distribution function, while probit model assumes normal distribution.

The two models are not without limitations. The two models can only be used to explain the influencing explanatory variables on decision to adopt or non-adoption, but does not include the intensity of adoption, therefore it is a type of static model. To solve this issue, it has been suggested that a two-stage investigation is done. The first is to use the two models to explain the probability to use the technology and then use a conditional model with the logarithm of technology as a dependent variable for quantity of use. For others like Akinola & Young (1985) applied the tobit model to analyze the adoption process of cocoa spraying chemicals among Nigerian farmers. They have recognized that it is a simultaneous decision to adopt or not to adopt and by how much. The model assumes that there is a lower or upper limit of many variables with a threshold as a crossover point. In the dichotomous characteristics, adoption = 1 and non-adoption = 0. Whenever there are enough influential factors that drive the value over the threshold or the breaking point, then the value has the probability of 1, and the same for the lower limit at 0. The implication for this model is for policy that could enhance the variable that nears the breaking point, leading to adoption.

Another approach that has been used to analyze adoption of direct marketing strategy of organic farmers is the double-hurdle approach used by Detre et al. (2011). The double hurdle approach is an improvement of the Tobit model proposed by Cragg (1971). It allows for the estimation of participation decision first and then level of that decision. In DMS case, the farmer decides to participate or not and then report income received from it for instance.

A more dynamic models used by Pornpratansombat e al. (2011) is descriptive analysis to summarize farmers' characteristics and used the Cox proporational hazards model for adoption decision. The model allowed for dynamic modeling taking into account of time factor and can estimate farmers with given attributes will adopt organic practices in a particular year, given that adoption had not occurred by that time. Another model is called duration analysis, which also takes time into account. For instance, Lapple tried to investigate the adoption and exit decision of a technology and the 'time' variable of interest is the length of time until a certain event occurs or until the measurement is taken or the length of time it takes a farmer to adopt the technology given that by that time the farmer has not adopted yet.

2.5. Specificity

It should be noted about the specificity of samples in this research as compared to other research. The first specificity is that the adopting technology in this case is the Q-GAP rice, which is not really a technology, but a label or certification that this farm has passed through the guidelines established by the government that it is safe for consumption. The guideline also tries to promote a reduction in input costs for farmers. In addition, since the guideline for Q-GAP is not a very strict guideline if we compared it to other standards such as from IFOAM, Free Trade, or GlobalGap, therefore some of the farmers in the Central Region could readily adopt the standard easier than others that may be using high level of input use. This in a way also points to the distance a farmer is to the guideline. It must also be noted that many of the rice farmers in the Central Region uses high inputs of chemical fertilizer, pesticides, and often times use of hired services (transplanting, harvesting, or land development).

Chapter 3

Methodology

The methodology to fulfill the above mentioned objectives will be explored in this chapter. With consultation with the Rice Department of Thailand, an official responsible for Q-GAP for rice has recommended the research site to be in the Central Region of Thailand. The first section in this chapter will describe the general characteristics of the Central Region. The conceptual framework is also presented to show the outline of the study. In the later chapter, specific variables are selected from literature review to be included in this study. And the last chapter is to be allocated for specific analysis technique.

3.1. Study area: characteristics of rice field in central region of Thailand

The growing seasons for rice in Thailand is during wet (in-season) and dry season (off-season). The wet season lasts from June to August and can be harvested from October to January, while dry season lasts from February to April and harvested between April to June (Wiboonpongse & Chaovanapoonphol, 2001). For dry season or off-season rice, the harvesting period is very certain, these rice are usually planted on irrigated lands. Usually, the traditional varieties are cultivated in the wet season (in Thai "นาปี" or "na pee", while high-yielding new varieties are grown in wet and dry season (in Thai "นาปรัง" or "na prang").

According to the FAO, about 40% of Thailand's land area is under rice cultivation, which are classified as irrigated, rain-fed lowland, deep water, and upland ecosystem. The figure 1.1 below shows the different categories and their characteristics (Bambaradeniya & Amarasinghe, 2003) (Kupkanchanakul, 2000).

Table 3.1 Rice cultivation types (Bambaradeniya, 2003 and Kupkanchanakul, 2000)

Cultivation type	Characteristics	Region	% coverage in Thailand
Irrigated	Environments which have sufficient water available during the entire growing season, with controlled shallow water depth between 5 to 10 cm; this helps by increase rice production in the wet season and dry season	Central	<20
Rain-fed	Lowland environments which are mainly dependent on the duration of rainfall and hence with an uncontrolled shallow water depth, ranging from 1-50 cm. This contributes to rice production in the wet season	Northeast; North	>80
Deep-water	Environments which are unfunded fields with maximum sustained water depths from 0.5 to 3 m; mostly in the central plain with long periods of deep	Central plain	N/A

	flooding annually; generally low yield		
Upland	Environments which are bunded or unbunded rain-fed fields with no surface or rhizosphere water accumulation; drastic reduction of this category	North	Small contribution (1%)

In areas where rainfall is available year round, these two types of rice can be cultivated without any major constraints. The total rice production from 2008 to 2010 totaled about 32 million tons: about 23.24 million tons in wet season and about 8.42 million tons in off-season[1] (Office of Agriculture Economics, 2010).

3.1.1. Boundary of the central region

The central region of Thailand is characterized geographically by its division from the northeast region Phetchabun mountain range and another mountain range separates it from Myanmar to the west (IRRI, 2010). It is an area that covers the "broad alluvial plain of the Chao Phraya River".

The formal division of provinces in Thailand allocates 21 provinces as the central region according to their geographical differences. These provinces include: Kampaengphet, Chainat, Nakhon Nayok, Nakhon Pathom, Nakhon Sawan, Nonthaburi, Pathumthani, Phra Nakhon Si Ayutthaya, Phichit, Pitsanulok, Phetchabul, Lop Buri, Samut Phrakarn, Samut Songkram, Singburi, Sukhothai, Suphanburi, Saraburi, Ang Thong, and Uthaithani. Out of these provinces, low-land off-season rice cultivation occurs mostly in Suphanburi, Nakhon Sawan, Phichit, Phisanulok, and Kampaengphet (Office of Agricultural Economics, 2010). The majority of rice production in the central region is white rice.

3.1.2. Rice yield and productivity

In terms of yield and productivity, yield is defined as the amount of a natural resource (in this case rice) that is harvested over a given period of time, usually a year (in t/ha/crop or t/ha/year) and productivity is defined as the rate of output per input, a measure of efficiency. Globally, it is estimated that around 556 million tons of rice is produced, while by 2025, the world will need 765 million tones, signifying the need to increase yield and productivity for food security.

Depending on the type of rice cultivation environments: irrigated, rain-fed, or upland cultivation, yield and productivity varied. The IRRI article on Rice Production and Processing, mentions that irrigated intensive temperate systems can produce more than 10 tons per hectare and its average yield is at 5.4 tons per hectare, which contributes the most to rice production. In many developing countries, irrigated rice yield is estimated around 4-5 ton/ha (FAO, Muhamud). On the other hand, poor rain fed conditions can only give 1 ton per hectare for rainfed lowland rice production and highest at 2.5 tons per hectare. This usually low production stems from uncertainty of rain in terms of timing, duration, and intensity of rainfall. Because of these constraints farmers tend not to apply fertilizer nor grow improved varieties, thus farmers in these region remains poor. And, upland

[1] Data is taken from irrigated area and non-irrigated area.

cultivation produces the less yield, only about 1 ton per hectare, and contributes to only 4% of total rice production.

There have been attempts at the global level to increase yield and productivity of staple food crops to feed the growing population by the Green Revolution. This initiative did increase rice production, but recently growth has been slowing down since 1991 (Kupkanchanakul, 2000). For instance, irrigated rice during the Green Revolution increased rice yield, while other areas may not improve.

According to the FAO article by Mahmud, the future rice production will depend on improved productivity and efficiency that comes with innovative technologies such as hybrid rice, new plant type, and possibly transgenic rice to increase the yield and thereby increasing productivity.

In terms of input, seed selection process is a very important factor in the beginning of rice cultivation. Rice seeds should be chosen according to its suitability to the environmental factors. By choosing the right seed, it will ensure viability and crop productivity, which according to the IRRI, good quality seed can increase yield by 5-20%. In addition,

> "using good seed leads to lower seeding rates, higher crop emergence, reduced replanting, more uniform plant stands, and more vigorous early crop growth. Vigorous growth in early stages reduces weed problems and increases crop resistance to insect pests and diseases. All of these factors contribute to higher yields and more productive rice farms." (IRRI, n.d.)

Land preparation is also related to yield. Tillage should be done to a depth of the rooting zone to support rice roots physically to allow moisture and nutrients absorption for highest potential yield. And after land preparation is done, land leveling to ensure that water is used efficiently.

The IRRI categorized crop establishment into two groups: transplanting and direct seeding. For transplanting, the seedlings are established in a separate nursery area for 20 to 80 days and then they can be transplanted in the rice field. This technique is quite labor intensive, which can be transplanted manually or by a machine. Depending on specific conditions, transplanting can give higher yield than direct seeding (Nielsen, 2004). As for direct seeding, the technique involves 'broadcasting' the dry seeds or pre-germinated seeds by hand or by the machine. Usually this technique is done for rainfed and deepwater ecosystems.

Since rice depends on water, it is sensitive to water shortages and relates directly to yield when rice plant is put under water stress. While farmers in irrigated lowland rice cultivation may leave their rice field flooded with water, rainfed rice field may require alternative techniques that ensures that rice plant are not affected by water stress. These techniques include saturated soil culture, alternate wetting and drying, raise beds, mulching, and use of aerobic rice to cope with dryer conditions. It is a thumb rule that rice takes 5 cubic meter of water to produce 1 kg of rice (Nielsen, 2004).

And, the most important factor is nutrient requirements by rice plants, as each growth stage requires different nutrients. Naturally, the flooded rice field actually retains soil organic matter as well as receiving free nitrogen from biological sources. This contributes to about 3 tons per hectare per crop without any nitrogen fertilizer. And with limitations, with an increase in 1 kg of nitrogen fertilizer, about 10-15 kilogram of rice can be produced (ibid). Nitrogen seems to be the main nutrient, which influences the yield potential of rice.

Below is a table taken from the IRRI report in 2004 on "Rice is life: scientific perspectives for the 21st century" that summarized the typical yield from different ecosystems across different countries.

Table 3.2 Rice yields in different countries and ecosystems (Hossain and Narciso, 2004 as cited in IRRI)

Country	Ecosystem	Year	Rice yield (t ha^{-1})
Bangladesh	All	2000	3.6
Burkina Faso	Rainfed	1987-190	2.5
India	Irrigated	1995-96	5.2
	Rainfed	1995-97	2.3
United States	Irrigated	2001	7.0
Japan	Irrigated	1999	6.4
Philippines	All	1992-2000	3.1
Thailand	Irrigated	2000	4.2
	Rainfed	2000	2.2
South Korea	Irrigated	1999	6.6
Vietnam	Irrigated	2000	4.2

3.2. Survey sampling

The central region of Thailand is mainly dominated by irrigated areas, while rain-fed areas coverage is minimal.

Farmers were divided between those who adopted the Q-GAP rice and those who did not adopt. The sampling plan solely depends on the available comprehensive list of farmers who has been trained and participated in Q-GAP program in the Central Region from the Rice Department. Comprehensive list of farmers are by province in the Central region where Ayutthaya proved to have the most comprehensive list and longer time period for program implementation. Ayutthaya Province was selected as the target area to investigate.

Since the Central Region is very much dominated by irrigated rice farming, all samples of farmers are from rice fields in irrigated area, which is representative of the region. The farmers who are non-adopters are the control group.

Table 3.3 Characterization of non-adopters, adopters, and disadopters

Non-adopters	Adopters	Disadopters
- have knowledge of rice Q-GAP, but decided not to adopt or cannot adopt because they cannot pass the guideline	- have knowledge of rice Q-GAP and decided to adopt in the first year and the year after	- have knowledge of rice Q-GAP and decided to adopt in the first year and the year after, but later decided to discontinue

3.3. Rice Farmers Sampling

With currently limited information, the researcher has proposed this strategy for sampling: to select farmers for an interview from different years that Q-GAP is promoted in different villages in Ayutthaya Province. Q-GAP certification was initiated in 2004 and it is on an annual renewal basis. Additionally, the Department of Agricultural Extension would promote Q-GAP in different provinces each year. Therefore, the strategy is to take the list from 2006 until 2012 from Ayutthaya Province as this is the only available data. Afterwards, stratified sampling technique is used to select villages in one province and farmer's names are also randomly selected for interview. If this was not possible, then comprehensive list of farmers are taken for contacting the farmer and farmers are informed of the interview date and time.

It should be noted that the time of Department of Agricultural Extension or Ayutthaya Rice Research Center visit for Q-GAP training does not always mean that the farmer automatically adopts Q-GAP. Rather, the farmer is asked whether he/she had received a Q-GAP certificate, memories of bookkeeping for Q-GAP, visit of auditing officers, or if he/she had given their name of village heads or government official for participating in the program along with other questions during the interview (see appendix II).

3.4. Phase I Determining the rate of adoption over time

For this phase, the data obtained from the Rice Department were compiled into a graph showing the general trend of adoption for target area. For this phase, a simple frequency count is used.

3.5. Phase II Determining factors influencing adoption, non-adoption, and disadoption

For this phase, factors are divided into environmental, social, and economic characteristics of the farmers. Based on literature review of used factors and significant factors, they are selected according to their suitability to the context of rice Q-GAP.

3.5.1. Environmental characteristics

Though total farm size has been used in many case studies, its significance is still unclear; it is still worthwhile to include it as a factor. The existing behavior of the rice farmer that includes the use of pesticide, fertilizer, and herbicide could be an interesting factor as it will show how each farmer may easily adopt rice Q-GAP than others. Land or soil quality is also an important factor that might help in understanding whether this issue can have an effect.

The percent of farm size allocated to Q-GAP is for those who have already decided to adopt rice Q-GAP. It measures whether the rice farmers is testing or already have the buy-in for rice Q-GAP. In addition, changes of farmers' management have to change from before adoption to after adoption to show the distance of the farmer to obtaining the standards.

3.5.2. Social characteristics

Education has been an important factor for farmers to switch to more sustainable agriculture. Years of farming experience could also help in terms of knowledge and risks taking behavior, while knowledge of rice farming impacts on environment has been investigated as a factor that influence adoption. It has also been mentioned that communication and knowledge helps in influencing farmers, so frequency of contacts with extension service office could be a factor. In the context of Thailand, it is often that social forces or conforming to society is a factor that influence Thais' behaviour, so number of known neighbors who adopted Q-GAP as well as the farmers' position in society should be included. And, finally level of knowledge on Q-GAP could also be a determining factor as there is a difference between farmers who knows the concept of Q-GAP and those who knows the concepts and can actually remember some of the guidelines.

Labour has been a major constraints in rice cultivation in Thailand. This is why much more farmers have turned to hire services. So, for this, household labours involved in rice farming in the central region may be very low, but should be included to confirm this fact.

3.5.3. Economic characteristics

Price is a very important factor that can determine a decision for farmers to adopt certain technology as they must investment or change their current practice, so it is important that the expectations of price is known. It would be interesting to see the kind of price received and expected for farmers who have adopted Q-GAP and the expectation. This is also similar to yield expectations, whether or not after Q-GAP, farmers' expectations are met.

Off-farm income could also play a role in understanding the contribution of rice cultivation to the farm (whether or not rice cultivation is important to the farmer). Market access of rice is also important for those who are adopters. It would be interesting to know where markets for Q-GAP are and if possible how to develop this market further.

Again, labour is an important resource for rice cultivation, and number of hired labour and number of hired services could be an interesting factor that might determine adoption or non-adoption.

And, the type of land ownership could also be a significant factor, which will determine whether or not the decision to adopt or not to adopt lies with the farmer or someone else. Income and yield that is expected from Q-GAP could show the disadoption behaviour.

Table 3.4 Variables for analysis, hypothesis, and values for analysis

Dependent variables		
Adoption and non-adoption	Qualitative dummy Adoption = 1 Non-adoption = 0	
Continued adoption and disadoption	Qualitative dummy Continued adoption = 1 Disadoption = 0	
Independent variables for analysis		
Environmental characteristics	Hypothesis	Values
1. Total farm size	With larger farm size, it shows that a farmer can be wealthy and are able to take more risks and if farmers adopts at a significant level for this factor, it will also show the minimum farm size that a farmer will adopt H: As farm size increases, farmers are willing to adopt Q-GAP	Quantitative Continuous
2. Chemical fertilizer: quantity during wet season, dry season or all year; brand name, formula, frequency, cost	One of the Q-GAP guideline is on use of chemical fertilizer H: The frequent the use of prohibited chemical fertilizer, the less farmers are willing to adopt Q-GAP	Quantitative Continuous
3. Use of pesticide: frequency of use during wet season, dry season or all year; brand of pesticide, frequency, cost	One of the Q-GAP guideline is on use of pesticide (hazardous substances) H: The frequent the use of prohibited pesticide, the less farmers are willing to adopt Q-GAP	Quantitative Continuous
4. User of herbicide	H: the more a farmer use prohibited herbicide, the less chance they are of adopting Q-GAP	Quantitative Continuous
5. For adopters, % of farm size allocated to Q-GAP rice	For those who actually adopts the Q-GAP, farmers may choose to allocate a certain part of their farm H: For those adopters who adopts Q-GAP 100% on their farm, they may have the tendencies to continue the adoption next year. But, for those who may allocate a small amount of land for Q-GAP, they might be experimenting with the Q-GAP	Quantitative Continuous
6. Practices changed after adoption	The changes that farmers have to make after adoption of Q-GAP could show the tendency of future adoption H: The more that farmers have to change their practices in the farm, the more that they will be unwilling to adopt Q-GAP	Qualitative Discrete 1 change 2 changes 3 changes 4 changes 5 changes
Social characteristics		

1. Years of education	Education of farmers could help in decision-making for adoption of Q-GAP as they may understand the consequences of the impacts of farming and they may have more capacity to do bookkeeping skills H: Many years of education of farmers will support farmers' decision to adopt Q-GAP	Quantitative Continuous
2. Years of farming experience, when a farmer starts making decision on their farm	Farming experience could help offset 'risks' taking into the unknown as farmers are more knowledgeable and could be more adaptable to changes H: The more experienced the farmer, the more likely the farmer will adopt Q-GAP	Quantitative Continuous
3. Perception of rice farming impacts	Perception of rice farming impacts is a play with 'guilty' consciousness. H: If farmers perceive that their farming is having a negative impact on environment in general, they may feel more likely to adopt Q-GAP approach	Dummy Y= 1 N =0
4. Frequency of extension services contacts	Communication and information dissemination to farmers is important as a way to persuade for adoption of technologies H: The more a farmer is visited by an extension service officer, the more likely a farmer will adopt Q-GAP	Quantitative discrete
4a. Frequencies of farmer contacting government office about Q-GAP	A more proactive farmer who are always communicating to the extension office could be more inclined to adopt Q-GAP H: The more that a farmer contact the government office about Q-GAP, it shows a farmers' interest in adopting Q-GAP	Quantitative Discrete
5. Participation in rice training	Being able to attend training services helps improve farmers' knowledge H: Farmers who have attended trainings are more prone to adopt Q-GAP as they may have more knowledge than other farmers	
6. Number of known neighbors who adopted Q-GAP	The community that a farmer is living in could have an impact on technology adoption. It is quite often that farmers 'copy' one another in terms of technology adoption. It also shows good practices, maybe the neighbors have found that adopting the guideline is beneficial, so the farmer will be more likely to adopt H: The more number of neighbors the farmer knows that adopted Q-GAP, the more likely	Quantitative Discrete

	the farmer will adopt it	
7.a Total number of household members	The more dependents a farmer has, the more the farmer will take less risk, hence low adoption	Quantitative Discrete
7.b Number of household labour allocated to rice farming	Labour in the household that is responsible for rice farming can also determine whether a farmer will be more or less inclined to adopt H: As the number of labour is used for cultivating rice, a farmer may not decide to adopt the Q-GAP as they may have more mouths to feed and don't want to take more risks	Quantitative Discrete
8. Position in society	Position in society could be a factor that affects the wealth and 'face' in society for a farmer. It also shows that the person could be more innovative and take more initiatives H: If a farmer has a position in society (involved in an association, or has a respected position in the community), the farmer maybe more inclined to adopt	Qualitative dummy No association with any organization = 0 At least association with an organization and a position in that organization = 1
9. Communication channels farmers rely on for learning about Q-GAP other than from extension services from the government	It would be interesting to see if there are other communication channels for farmers other than from extension services H: If a farmer has more knowledge of Q-GAP, they may be more inclined to adopt it at least to experiment it	Dummy variables Yes, the farmer learned about Q-GAP from other channels = 1 No, only through government = 0
10. Age	Younger generations may like to take risk more than older generations who are familiar with the conventional way to do farming H: the younger the farmer, the more willingness to adopt Q-GAP	Continuous
11. Gender	There may not be any significant relationship between Q-GAP farmers who are males or females because participation in the Q-GAP depends more on extension services H: no significant relationship on gender	
Economic characteristics		
1. Better price expectation before adopting Q-GAP	H: If a farmer expects better price after Q-GAP adoption, then he/she will be more likely to adopt it	Qualitative dummy variables Better price = 1 Not better = 0
2. Cost reduction expectation	H: If a farmer expects their cost to reduce after Q-GAP adoption, then he/she will more likely adopt it	Qualitative dummy variables Cost reduction = 1 No cost reduction =

		0
3. Yield expectation	H: If a farmer expects that their yield will increase after adopting Q-GAP, he/she will more likely adopt it	Qualitative dummy variable Better yield = 1 No better yield = 0
4. Access to market/better sales	H: If farmers expects sales from Q-GAP to improve, then they will be more likely to adopt it	
4. Off-farm income and income not related to rice farming	If a farmer has off-farm income and income not related to rice farming, it can be interpreted two ways: farmers are better off financially so they can take more risks that will lead to adoption, but farmers can also not adopt because they already are wealthy H: Since Q-GAP guideline suggests cost-reductions with appropriate input use, farmers who may have other income not related to rice would not adopt Q-GAP as they might have other income	Quantitative Continuous
3a. Sales of rice to buyers	The major buyers of rice could have an impact on behaviour of rice farmers. H: If farmers are selling rice to buyers (millers or brokers) that gives importance to Q-GAP, then farmers would be more likely to adopt Q-GAP	Quantitative Nominal
3b. Support from downstream buyers related to Q-GAP	With support ranging from trainings, or knowledge support could help as an incentive for farmers to continue adopting Q-GAP H: If farmers are receiving supports from buyers who gives importance to Q-GAP, they maybe more likely to continue	
	The number of hired labour services on the rice farm H: The more hired labour, the less likely the farmer will adopt Q-GAP	Quantitative Discrete
6. Number of hired services	Hired services are a predominant force in Thai rice farming in the Central region H: the more hired services a farmer use, the less likely they will adopt Q-GAP because they have no control over services operation.	Quantitative Discrete
7. Current income from rice farming (per ton)	H: If income of rice per ton received is lower than the market, then it is possible that the farmer will adopt Q-GAP to try to reduce input-cost	Quantitative Continuous
8. Input costs of rice farming	H: Farmers who adopts Q-GAP are more likely to reduce costs than other farmers	Quantitative Continuous

9. Land ownership: owner, leased land, contract farming	H: If farmer is the owner of the land, it is likely that he will adopt the Q-GAP as the farmer has full control of the land	Qualitative dummy variables Complete land ownership (include mixed land ownership and rent land) = 1 Rent land = 0
10. Perception of future rice production	This factor tries to explain whether the farmer sees himself/herself still in the business in the future for themselves or family or do they want to reap the benefit as much as possible today H: It could be likely that farmers who are interested to stay in the business would try to take more risks and adapt	Qualitative dummy variables Yes = 1 No = 0
11. Perception of future rice practices (stay the same or switch to organic)	It would be interesting to also consider where they see themselves if they continue the business (to try to stay the same or possibility to play with organic rice in the future) H: farmers who may adopt Q-GAP could use it as a stepping stone to adopt other standards	Yes = 1 No = 0

Disadoption	Hypothesis	Values	Unit
Perceived risk to Natural disaster (experience of drought, flood)	Nature instability (unpredictability of climate) has been identified in some works as a factor for farmers who failed to adopt the Q-GAP (Nathabuth, 2009) (Sathayakul, 2009) (Kamma, 2007) H: Experience of natural disasters such as drought or floods that is unpredictable could cause a farmer to disadopt	Dummy variables 1 = risks to natural disaster uncertainty 0 = no risks	1 or 0
Bookkeeping experience	Bookkeeping of on farm practices could be cumbersome to farmers. Even before adoption, some farmers are struggling with completing the bookkeeping (Kamma, 2007) (Boonprakom, 2009) H: The structure and	Dummy variable 1 = cumbersome experience 0 = easy to do	1 or 0

	detailed of the bookkeeping required for GAP practice may leads a farmer to stop the Q-GAP		
Off-farm job	Off-farm job was identified as one of the major key factor for the probability to exist organic farming. This is because organic farming requires labour inputs and a non-presence of a farmer at the field makes it difficult to adjust to the new system (Lapple & Van Rensburg, 2011). This is also confirmed in another case study in Madagascar on SRI or system of rice intensification (Moser & Barrett, 2006) It could play a role in the Q-GAP too. H: If a farmer has off-farm jobs (salaried employment), he/she might be likely to disadopt Q-GAP	Dummy variable =1 have off-farm job =0 does not have off-farm job	1 or 0
Experience with the certified program	It was found in the Madagascar research that experience with SRI program itself is one of the factor that contributed to the disadoption practice (Moser & Barrett, 2006), which is measured by the increasing or decreasing of farm size for the program. For example, a farmer who experimented with too size of the small plot disadopt and does not see the increase in productivity H: Q-GAP certified farmer will disadopt as a result of the size experimented with Q-GAP	Land size allocated to Q-GAP	Rais
Social conformity	In the SRI case study, it was found that social conformity also played a role in that it was more likely to continue SRI if more farmers were practicing SRI the	% of farmers practicing Q-GAP the previous year in the village	percentage

	previous year and disadopted when farmers in the previous years disadopted H: This factor could play a role as Thai society is also a place where social conformity dominates people's life. As more farmers learn about their neighbors' disadoption, a farmer is more likely to disadopt too		

Variables mentioned in the above table were investigated and included into the interview questions (see Appendix V.). Upon entering data for analysis, some cases were dropped due to missing values and outliers as tested with histogram and Q-Q plots. Through checking cook's distance and leverage values, some cases were also dropped. In total, 222 cases were used for analysis. Binary regression model was used for explaining adoption and non-adoption behavior for first timers and for second time adopters and disadopters. Independent variables entered include: number of public school years, frequency of government contact, number of known adopters of Q-GAP, total land size, channel of Q-GAP, rice farming experience, perception of environmental impacts from farming, attendance to rice training, household size, number of household member in rice farming, number of household member not in rice farming, dependents, social positions, additional income, gender, expectation to be in organic rice business, expectation for better price, expectation for better yield, expectation for better access to markets, and expectation to reduce cost. As for dependent variable, it is the behavior to adopt or non-adoption of Q-GAP.

Chapter 4

Results and Discussion

This chapter summarizes the results from the interview by beginning with simple descriptive characteristics and later on pinpointing the significant characteristic variables that explain a farmers' decision to adopt or non-adoption of Q-GAP. Disadoption is briefly discussed. Finally, a comparison of management practices of farmers who adopt and non-adoption of Q-GAP is presented.

4.1. Q-GAP adoption trend in Ayutthaya

List of farmers participating in Q-GAP was retrieved from the Ayutthaya Rice Research Center, Rice Department, and the Provincial Agricultural Extension Office. Q-GAP was started in Ayutthaya in 2007 and continued to 2012, the total number of rice farmers being promoted with Q-GAP according to the government's record is about 692 farmers from 85 sub-districts. Figure 2 below shows the trend or the changes of numbers of farmers targeted for Q-GAP promotion. Promotion can occur in two major ways. The first is through the Rice Research Center in Ayutthaya Province where the center's officers contact the farmers directly or through community center for rice farming, which is under their office. The second way is for the Department of Rice to cooperate with local agricultural extension offices that are familiar with local farmers.

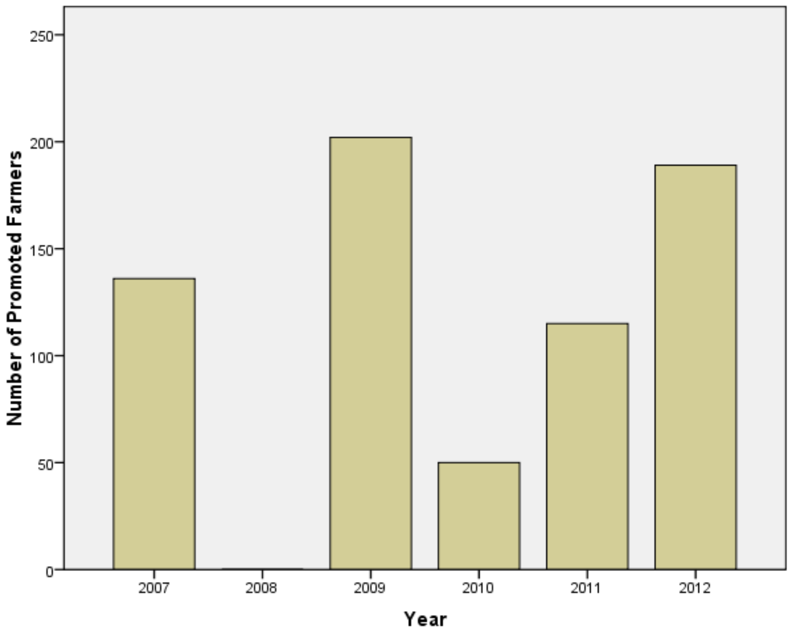

Figure 4.1 Number of new farmers promoted with Q-GAP in Ayutthaya Province from 2007 to 2012 (source: data from Department of Rice and Rice Research Center Ayutthaya Province).

The figure showed differences in the numbers of farmers being promoted with Q-GAP. After the promotion process is completed, farmers are given a choice to register by for the Q-GAP by sending in their name with the officers or it can be done through the village chiefs or soil doctors.

It is also important to note that the Q-GAP certificate is valid for 3 years. After 3 years, a farmer must register again to express their continuation. Every year, there will be random check of each farm. Each time the farmer passes the farm auditing and checking of the bookkeeping records, a farmer receives a certificate as shown below.

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(Certificate for Good Agricultural Practice of Rice Production)

รหัสรับรอง กษ 09-22-9001-50-00825

เงื่อนไขวันหมดอายุ ต้องมีผลการตรวจติดตามประจำปี หลังจากปีที่ออกใบรับรองตามเอกสารแนบ

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(Certificate for Good Agricultural Practice of Rice Production)

มาตรฐานการรับรอง การปฏิบัติทางการเกษตรที่ดี ตามระบบการจัดการคุณภาพ : GAP ข้าว
ขอบข่ายที่ให้การรับรอง การผลิตข้าวเปลือกเพื่อใช้รับประทานและแปรรูป
มอบให้แก่ นายมนัส แก้วชูมา รหัสรับรอง กษ 09-22-9001-50-00825
สถานที่ 9 หมู่ 2 ต.ห่อหมก อ.บางไทร จ.พระนครศรีอยุธยา
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(ลงนาม)
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Figure 4.2 Example of Q-GAP certificate front and back for 2008 to 2011 as retrieved from the farmer (style 1)

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(Certificate for Good Agricultural Practice of Rice Production)

มาตรฐานการรับรอง การปฏิบัติทางการเกษตรที่ดีตามระบบจัดการคุณภาพ : GAP ข้าว

ขอบข่ายที่ให้การรับรอง การผลิตข้าวเปลือกเพื่อใช้บริโภคและแปรรูป

มอบให้แก่ นางสุมาลี จิตรัตน์ พื้นที่ปลูก 40 ไร่ กลุ่มข้าว ทั่วไป

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(ลงนาม)

(นายประเสริฐ โกศัลวิตร)

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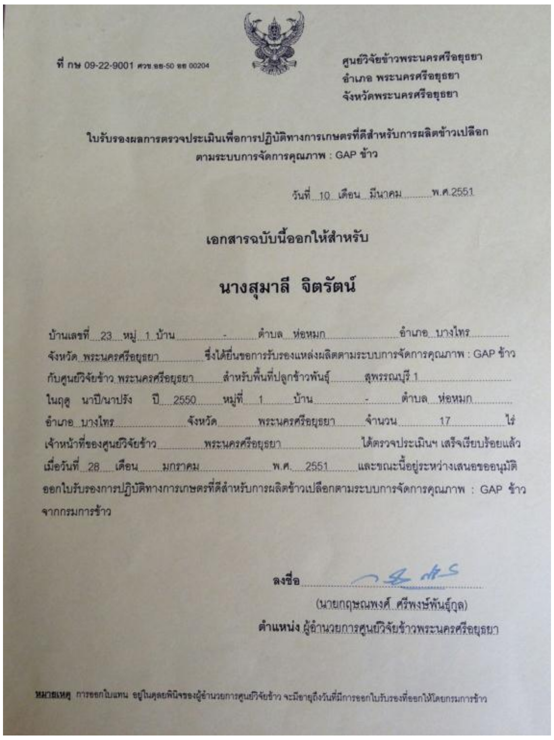

ที่ กษ 09-22-9001 ศวข.อย-50 อย 00204

ศูนย์วิจัยข้าวพระนครศรีอยุธยา
อำเภอ พระนครศรีอยุธยา
จังหวัดพระนครศรีอยุธยา

ใบรับรองผลการตรวจประเมินเพื่อการปฏิบัติทางการเกษตรที่ดีสำหรับการผลิตข้าวเปลือก
ตามระบบการจัดการคุณภาพ : GAP ข้าว

วันที่ 10 เดือน มีนาคม พ.ศ.2551

เอกสารฉบับนี้ออกให้สำหรับ

นางสุมาลี จิตรัตน์

บ้านเลขที่ 23 หมู่ 1 บ้าน - ตำบล ห่อหมก อำเภอ บางไทร จังหวัด พระนครศรีอยุธยา ซึ่งได้ยื่นขอการรับรองแหล่งผลิตตามระบบการจัดการคุณภาพ : GAP ข้าว กับศูนย์วิจัยข้าว พระนครศรีอยุธยา สำหรับพื้นที่ปลูกข้าวพันธุ์ สุพรรณบุรี 1 ในฤดู นาปี/นาปรัง ปี 2550 หมู่ที่ 1 บ้าน - ตำบล ห่อหมก อำเภอ บางไทร จังหวัด พระนครศรีอยุธยา จำนวน 17 ไร่ เจ้าหน้าที่ของศูนย์วิจัยข้าว พระนครศรีอยุธยา ได้ตรวจประเมินฯ เสร็จเรียบร้อยแล้ว เมื่อวันที่ 28 เดือน มกราคม พ.ศ. 2551 และขณะนี้อยู่ระหว่างเสนอขออนุมัติออกใบรับรองการปฏิบัติทางการเกษตรที่ดีสำหรับการผลิตข้าวเปลือกตามระบบการจัดการคุณภาพ : GAP ข้าว จากกรมการข้าว

ลงชื่อ

(นายกฤษณพงศ์ ศรีพงษ์พันธุ์กุล)

ตำแหน่ง ผู้อำนวยการศูนย์วิจัยข้าวพระนครศรีอยุธยา

หมายเหตุ การออกใบแทน อยู่ในดุลยพินิจของผู้อำนวยการศูนย์วิจัยข้าว จะมีอายุถึงวันที่มีการออกใบรับรองที่ออกให้โดยกรมการข้าว

Figure 4.3 Example of Q-GAP certificate front and back for 2010 to 2013 as retrieved from a farmer (style 2)

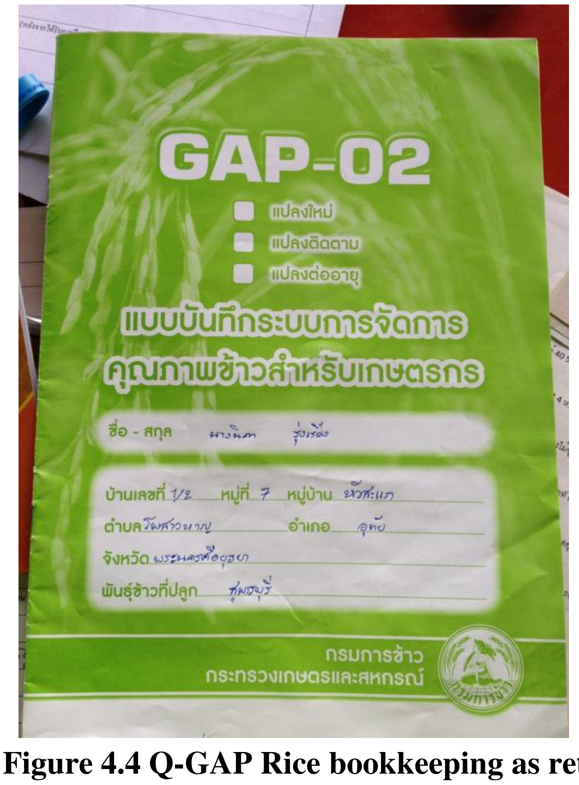

Figure 4.4 Q-GAP Rice bookkeeping as retrieved from a farmer

4.2. Descriptive characteristics of interviewed farmers

A total of 250 farmers were contacted and interviewed from 35 sub-districts as shown in Figure 4.5 and table 4.1. The farmers were selected from a comprehensive list and contacted.

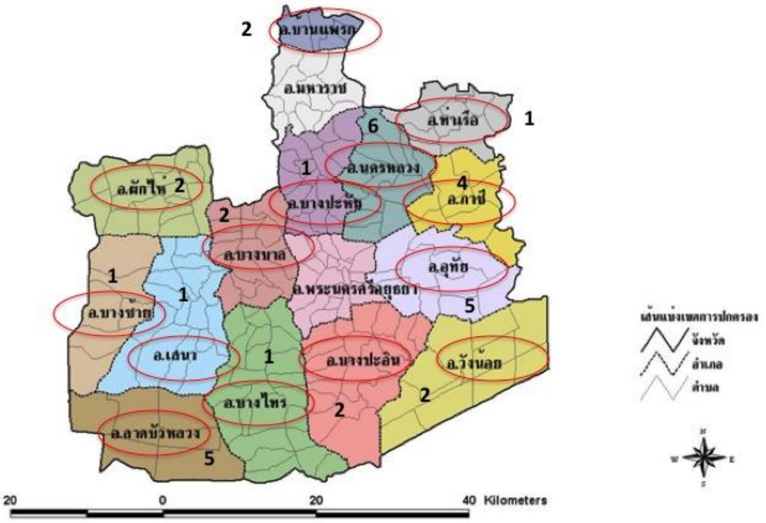

Figure 4.5 Map of Ayutthaya where interviews were conducted. Each number presents the number of sub-districts visited in that district (registered list from Department of Rice, Rice Research Center Ayutthaya Province, and Provincial Agricultural Extension Office).

Table4.1 Names of sub-districts visited-districts visited

Name of Sub-districts	Name of Districts
Khlong Noi	Ban Praek
Ban Praek	Ban Praek
Ban Rom	Tah Reau
Samthai	Nakhon Luang
Maela	Nakhon Luang
Pakjan	Nakhon Luang
Prahnon	Nakhon Luang
Ban Chung	Nakhon Luang
Nhong Pling	Nakhon Luang
Khok Muang	Phachi
Dong Ya Nang	Phachee
Phachee	Phachee
Nhong Nam Sai	Phachee
Hansang	Bang Pahan
Ban Yai	Phakhai
Lamthakien	Phakhai
Bang Luang	Bang Ban
Nam Tao	Bang Ban
Plai Klat	Bang Shai
Manwichai	Sena

Hor Mok	Bang Sai
Bang Padaeng	Bang Pa In
Wat Yom	Bang Pa In
Lam Tha Sao	Wang Noi
Ban Chang	Wang Noi
Phrayabanlue	Ladbualuang
Singhnat	Ladbualuang
Kooslaud	Ladbualuang
Ladbualuang	Ladbualuang
Maithra	Ladbualuang
Sena	Uthai
Nhongmaisung	Uthai
Sambandit	Uthai
Posaoharn	Uthai
Nhongnamsom	Uthai

From the interviews, out of 250 farmers, 174 (69%) answered that they adopted Q-GAP, while 76 did not adopt after Q-GAP was promoted to them. This percentage of adoption is similar to the other studies in Surin (82%) and Roiet Province (71%) (Nathabuth, 2009) and 61.8% for Ubol Ratchathani, Amnatcharoen, and Yasothorn Province (Sathayakul, 2009). Out of 174 of those who decided to participate in Q-GAP program, about 40 farmers decided to continue with the program after their certificate had expired. About 35% of farmers interviewed were females. The average household size is between 4-5 persons. As for education, some farmers have no public education experience while some have 18 years of public schooling. The age of farmers interviewed ranges between 23 years old to 82 years old. Similarly, experience for rice farming also ranged from 0 experiences to 60 years of experience with average experience to be at 28 years. Most answered that about 1 to 2 household members are involved in rice farming either as laborers themselves on their farm or they are managing it through hired services (phone farming).

In terms of land, some farmers have as small as 4 rais, while others are managing 190 rais, the mean of total land area is 43.67 rais. Ownership of land varied, some own all managed plots, and others rent all their plots, and some both rent and own their plots.

Phone or hired services were prominent among farmers in Ayutthaya. The average price for hiring farming services ranges between 50 to 60 Thai Baht per rai. The services include spraying of pesticide and herbicide, and distributing fertilizers, transplanting seeds, or weeding. Most of the time, laborers are from people within the community where each farmer could easily call and make appointments. According to the data collected, about 14.9% of farmers work on their rice field without hiring any services; 6.3% hired 1 service; 14.9% hired 2 services; and 64% hired for all 3 services for pesticide, herbicide, and fertilizer application.

Table 4.2 Q-Gap adoption and non-adoption frequencies

	Frequency	Percent	Cumulative Percent
Non-adopters	76	30.4	30.4
Adopters	174	69.6	100.00
Total	250	100.00	

Table 4.3 Gender frequencies

	Frequency	Percent	Cumulative Percent
Female	87	34.8	34.8
Male	163	65.2	100.00
Total	250	100.00	

Table 4.4 Access to land

	Frequency	Percent	Cumulative Percent
All rent land	118	47.2	47.2
All chanote	42	16.8	64.0
Mixed rent and chanote	90	36.0	100.00
Total	250	100.00	

Table 4.5 Additional income of individual interviewed farmer

	Frequency	Percent	Cumulative Percent
No	127	50.8	50.8
Yes	123	49.2	100.00
Total	250	100.00	

Table 4.6 Social positions (influential in society)

	Frequency	Percent	Cumulative Percent
Not influential	172	68.8	68.8
Influential	78	31.2	100.00
Total	250	100.00	

Table 4.7 Channel for knowing about Q-GAP

	Frequency	Percent	Cumulative Percent
Government	198	79.2	79.5
Other channels	51	20.4	100.00
Total	249	99.6	
Missing	1	.4	
Total	250	100.00	

Table 4.8 Rice training

	Frequency	Percent	Cumulative Percent
No	79	31.6	31.6
Yes	171	68.4	100.00
Total	250	100.00	

Table 4.9 Perception of rice farming impact on environment

	Frequency	Percent	Cumulative Percent
No	137	54.8	54.8
Yes	113	45.2	100.00
Total	250	100.00	

4.2.1. Descriptive characteristics of first time adopters and non-adopters by cross tabulations and mean

Total individuals used for preliminary descriptive characteristics by cross tabulations are 250. Significance tests used are independent sample t-test, non-parametric test by Mann-Whitney U, and Pearson chi-square test to give an initial idea about the potential differences between the two groups.

Table 4.10 Adoption and non-adoption descriptive characteristics and significance.

Group	**Characteristics**	**Item**	**Adopters**	**Non-adopters**	**Sig.**
Environment					
	Total farm size (ln total farm size)	Mean	41.67	48.25	.209*
Social capital					
	Years of education	Mean	6.75	5.67	.006**
	Years of farming experience	Mean	28.40	29.33	.695**
	Frequency of extension services contacts	Mean	2.43	.51	.000**
	Rice trainings	Yes	123	48	.239***
		No	51	28	
	Known numbers of neighbors with Q-GAP	Mean	8.45	3.03	.000**
	Number of household members	Mean	4.33	4.38	.838**
	Labour allocated to rice farming	Mean	1.802	1.69	.332**
	Influential position in society	Yes	66	12	.001***
		No	108	64	
	Government contacts	Government	129	69	.001***

	on Q-GAP				
		Other means	45	6	
Economic					
	Additional income	Yes	93	30	.042***
		No	81	46	
	Sales of rice per tonne in season 1	Mean	11,400	10,800	.073*
	Sales of rice per tonne in season 2		11,800	11,200	.060*
	Hired labour	Pesticide	135	61	.636***
		Herbicide	137	60	.970***
		Fertilizer	125	56	.764***
	Land accessibility	All rented land	78	40	.44**
		All chanote land	32	10	
		Mixed rent and chanote land	64	26	
Perceptions					
	Expectation yield increase	Yes	65	10	.000***
		No	109	66	
	Expectation price increase	Yes	94	12	.000***
		No	80	64	
	Expectation cost reduction	Yes	117	13	.000***
		No	57	63	
	Access to market	Yes	107	15	.000***
		No	66	61	
	Organic rice production	Yes	103	18	.000***

		No	70	58	
	Rice farming impacts on environment	Yes	76	37	.464***
		No	98	39	

Note: Significance test for each variable used as follows: *Independent-samples t-test; ** Non-parametric test Mann-Whitney U;*** Pearson Chi-square test

4.2.2. Descriptive characteristics of continued adopters by cross tabulations and mean

The total individuals used for preliminary descriptive characteristics calculations by cross-tabulations are 111. The reason why this number is presented and not 250 individuals because out of 174 individuals are adopters in the first round. However, recent adopters are taken out from calculations as they would have no possibility to renew the certificate. There are a total of 38 continued adopters and 73 disadopters.

Table 4.11 Continued adoption descriptive characteristics and significance.

Group	Characteristics	Item	Continued adopters	Disadopters	Sig.
Environment					
	Total farm size (ln total farm size)	Mean	46.24	43.15	.595*
Social capital					
	Years of education	Mean	6.58	6.29	.381**
	Years of farming experience	Mean	28.76	28.89	.948**
	Frequency of extension services contacts	Mean	3.37	2.44	.097**
	Rice trainings	Yes	32	52	.131***
		No	6	21	
	Known numbers of neighbors with Q-GAP	Mean	9.88	7.68	.450**
	Number of household members	Mean	4.84	4.47	.201**
	Labour allocated to rice farming	Mean	1.842	1.767	.314**

	Influential position in society	Yes	16	26	.504***
		No	22	47	
	Government contacts on Q-GAP	Government	31	46	.044***
		Other means	7	27	
Economic					
	Additional income	Yes	20	46	.290***
		No	18	27	
	Sales of rice per tonne in season 1	Mean	10,900	11,600	.189*
	Sales of rice per tonne in season 2	Mean	11,300	12,000	.093*
	Hired labour	Pesticide	32	61	.930***
		Herbicide	33	60	.528***
		Fertilizer	26	55	.436***
	Land accessibility	All rented land	13	44	.017***
		All chanote land	6	11	
		Mixed rent and chanote land	19	18	
Perceptions					
	Expectation yield increase	Yes	20	20	.009***
		No	18	53	
	Expectation price increase	Yes	23	37	.324***
		No	15	36	
	Expectation cost reduction	Yes	32	49	.054***

		No	6	24	
	Expectation access to market	Yes	28	42	.094***
		No	10	31	
	Truth yield increase	Yes	12	13	.099***
		No	26	60	
	Truth price increase	Yes	7	7	.184***
		No	31	66	
	Truth cost reduction	Yes	30	30	.000***
		No	8	43	
	Truth access to market	Yes	11	19	.742***
		No	27	54	
	Organic rice production	Yes	24	42	.458***
		No	13	31	
	Rice farming impacts on environment	Yes	13	26	.883***
		No	25	47	

Note: Significance test for each variable used as follows: *Independent-samples t-test; ** Non-parametric test Mann-Whitney U;*** Pearson Chi-square test

4.3. Social and economic variables explaining first time adoption and non-adoption

The -2 Log likelihood for the model is 151.104[a], the Cox and Snell R Square is .405 and the Nagelkerke R Square is .579. This means that the model can explain 57.9% of the cases, while the rest is unknown. The binary regression results are shown in table 7, 8, 9, and 10.

Table 4.12 Model summary of binary regression for adopters and non-adopters

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
151.108[a]	.405	.579

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Table 4.13 Classification table of binary regression for adopters and non-adopters

Observed		Predicted		
		Q-GAP Adoption		Percentage correct
		Non-adopters	Adopters	
Q-GAP adoption	Non-adopters	49	15	76.6
	Adopters	11	146	93.0
Overall Percentage				88.2

a. The cut value is .500

Table 4.14 Dependent variables in binary regression and its significance for adopters and non-adopters

Variables	B	S.E	Sig.	Exp (B)
Total rais	-.823	.363	.023	.439
Years in public education	.237	.088	.007	1.268
Rice farming experience	.029	.015	.055	1.030
Perception of rice farming impact on environment*	-.216	.435	.620	.806
Frequencies of government contact	.786	.225	.000	2.195
Rice training attendance*	-.063	.430	.883	.939
Number of known Q-GAP adopters	.085	.042	.044	1.089
Household labour allocated to rice farming	.534	.289	.064	1.706
Non-governmental Q-GAP communication channel*	2.349	.670	.000	10.480
Expected price increase*	1.332	.680	.050	3.787
Expected cost reduction*	1.280	.540	.018	3.595
Expected easy sales*	-.631	.731	.388	.532
Expected yield increase*	.024	.587	.967	1.025
Constant	-1.387	1.294	.284	.250

*perception for rice farming impact on the environment compared to no impact; rice training attendance as compared to non-attendance; non-government Q-GAP communication channel as compared to government communication channel; expected price increase as compared to no price increase; expected cost reduction as compared to no cost reduction; expected easy sales as compared to no easy sales; expected yield increase as compared to no yield increase

The analysis showed that total size of farm has a negative statistically significant impact in this study. This deviates from the hypothesis that as the larger the farm size, the adoption of Q-GAP will occur. This hypothesis was based on literature review with expectation that larger farm sized farmers has a lot of land which they can experiment with and a farmer can decide to spend a small amount of land to test the Q-GAP program. Actually, Knowler and Bradshaw (2007) found that land size variable is still inconclusive as to how it has impacted on adoption of conservation agriculture, which needs further investigation. Other literature in the past such as Feder et al. (1985) stated that larger fixed costs reduce the tendency to adopt and lowers the rate of adoption by smaller farmers, unless there is an effect of hired services. The Q-GAP case does have an effect of hired services, making adoption irrelevant to larger farm sizes. In another study about organic crops adoption, there is a similar negative relation effect on large farm size. Based on interviews with some Q-GAP adopters in this study, they have said that they allocated 5 rais to the program because the 5 rais plot was located next to their house. This means that the farmer can easily take care of the plot with close observations, while the larger plot that they have is far away so it is not suitable for the farmer to manage it according to Q-GAP. Other farmers suggested that the smaller the farm size, the easier it is for them to observe pests or control weed, because if they reduce pesticides or herbicides, they must frequently visit their fields more often than simple chemical spray. Some adopters expressed that following Q-GAP requires spraying natural pest prevention more often than chemical pesticide, so there is a cost of spraying frequently, which is not suitable for larger plot size. Some Q-GAP adopters confessed that they don't treat their Q-GAP plot and other plots differently. This shows the specificity of the Q-GAP program.

Education has a positive statistically significant impact. This variable accords to the literature review and the hypothesis in that as a farmer increases their public schooling experience, they have more tendencies to adopt Q-GAP. In the work of Just and Zilberman (1985) suggested that education improves a farmer's ability to adjust to changes and farmers with better education are the early adopters of modern technologies and apply modern inputs more efficiently throughout the adoption process. Similarly, a study in China on sustainable agriculture technologies adoption found that low educational level was one of the factors that explain low level of adoption (Liu, Wu, Gao, & Wang, 2011). Also, research in the Northeast of Thailand by Chouichom and Yamao (2010) found that higher education experience supported the switch to organic. In different cases whether it is sustainable agriculture, organic farming, or in this case Q-GAP, education is confirmed to play an important role in adoption. It can be interpreted that farmers who have been through school are more equipped with skills to understand the reason behind Q-GAP efforts and can follow the expectations from the program. An example of an expectation of the program is bookkeeping. If a farmer is illiterate, then they cannot keep participating in the program unless they have a family member helping them. It would also be difficult for them to follow trainings conducted by agriculture extension officers who are promoting Q-GAP. During the interview, there are some farmers who are doing their management bookkeeping on a computer and maintaining a printed report on farming and management, which summarizes their spendings, type of pesticide used, and other information. Other farmers have their personal bookkeeping in a book apart from the compulsory bookkeeping by Q-GAP in which they use to show the officers.

The number of neighbors known to be adopting Q-GAP proved to have positive statistically significant impact. Social cohesion factor was found to be one of the key variables in the work of Lestrelin et al. (2011) in Laos local community adoption of conservation agriculture. Other research from Moser and Barrett (2006) found the decision to adopt low external input rice production method to be influenced by learning of a farmer from other farmers. It is expected in the hypothesis that as the farmer has more knowledge about their neighbors adopting Q-GAP, they themselves will also adopt. It is very common that community members would decide to do similar management as each may feel that they don't want to be left out (social cohesion). In a way, it also gives them confidence. Additionally, when farmers were asked about whether or not they have thought of converting their rice farming practice to organic practices, for those who answered that they have thought about it, but has not done it, their reason was that they cannot alone change their practice, others surrounding them will also have to go through the process.

The frequency for coming into contact with the government has a positive statistically significant impact. It is very certain that any farmers who were contacted by the government will most likely adopt Q-GAP. This is because the Rice Department has been campaigning for it through their local offices and through the agricultural extension office.

Farmers must give cooperation to the government officers and it is most probable that farmers follow their suggestions. In addition, the researchers were presented at one of the meeting between rice farmers and government officer from Rice Research Center. During the meeting, the officer gave away free samples of beuvoria, a natural measures against pest and also explained Q-GAP program as incentives. Other research found similar results such as in the work mentioned in Just and Zilberman (1985) that similar to education, extension services contacts improves farmers' ability to adjust to changes. As in the China case for sustainable agriculture adoption, inadequate agricultural extension efforts were identified as a factor for low adoption (Liu, 2011). Similarly, Moser and Barrett (2006) found that learning from extension agents influenced the decision to adopt low input rice production method.

On the contrary the channel for Q-GAP communication is interesting because, it is the other channel other than through government proves to have an impact on adoption. Other channels in this case included family members, friends, attendance in trainings, brochures and leaflets, village chief, community leader, experience with GAP vegetable, and local soil doctors. One interesting example of this that the researcher came across was that one of the farmers was not only doing rice farming, but the farmer was also growing other agricultural produce (vegetables and fruits). The farmer had received Q-GAP for these other produce and it was proven that the farmer had better access to markets, therefore the farmer decided to adopt Q-GAP for rice as an experiment.

The expectation on cost reduction has a positive statistically significant impact on adoption. This value corresponds to the hypothesis that as more farmers expect to reduce their cost of production, they are more willing to adopt Q-GAP. Cost of production (fertilizer and chemicals to destroy rice natural enemies) is an important aspect of rice farming practice, but some farmers interviewed seem to look more towards improved market price rather than reducing costs. Cost reduction is the buy-in that the government tried to advertise. This variable proved that farmers who adopt Q-GAP do buy this assumption about Q-GAP, while a farmer who does not believe in this assumption tends to fall into non-adoption. In another research on Q-GAP of Hom Mali Rice in Sri Saket Province, the participated farmers has a lower input costs than those who do not participate, which reemphasize the reduction of costs from participating in Q-GAP practices.

On the same token, we can see that expectation of price by the farmers has a positive statistically significant impact. It also confirms with the hypothesis that as farmers expects the increased in price, they would be more willing to adopt Q-GAP. The research in Sri Saket Province on the Hom Mali rice also points out the farmers' perception about price as an encouragement for them to adopt Q-GAP rice. From the interviewed farmers, the average market price of rice is 11,000 Thai Baht per ton, some farmers are better off and can sell as high as 15,000 per ton while others can sell it at a very low price because of the low quality of rice produced. In addition, Q-GAP rice does not have buyers who are willing to give more than the market price, which lessen farmers' motivation to adopt. In Ayutthaya Province, there is only one rice mill that accepts Q-GAP rice, located in Ladbualuang Sub-district, but the rice must be Hom Mali or Pathumthani Hom Mali rice only, which farmers will earn 15,000 Thai Baht per ton, though Q-GAP does not limit rice production to Hom Mali rice only. Meanwhile, other rice millers or downstream buyers do not have separate management for Q-GAP rice. At this moment, there is no support from buyers.

The variable experience seems to have a positive statistically significant impact. The hypothesis stated that the more experienced the farmer, the more willingness to adopt Q-GAP. This logic is due to the assumption that with more farming experience, the farmer may have better understanding of rice farming practices and can judge or evaluate whether or not the Q-GAP program will be beneficial to them. It accords with other literatures such as in organic rice farming conversion where longer experience in farming and longer years of education supported the switch in Surin Province (Chouichom & Yamao, 2010). However, in a research by Knowler and Bradshaw (2007) on 21 research studies on conservation agriculture viewed that experience effect is still inconclusive.

We can conclude that at this point, first Q-GAP adoption is linked to some identifiable factors apart from frequencies of government contacts, which are total land size, education, experience, number of neighbors known to adopt Q-GAP, non-government communication channels, cost expectation, and price expectation.

4.4. Management practices of interviewed farmers: pesticide, herbicide, and fertilizer use of first time adopters and non-adopters

One of the major advertisements by Q-GAP program is cost reduction through appropriate use of chemical pesticide, herbicide, and fertilizer. Also, it promotes mixed use of chemicals and natural preventative measures for rice cultivation rather than complete chemical practices.

One-way ANOVA was used to compare the means of different dependent variables as a result of adoption or disadoption. In this comparison, we may also need to consider seasonality of rice farming. The dependent variables include frequency of fertilizer, pesticide, and herbicide application; nitrogen amount counted from chemical fertilizer application per season; and cost of inputs for fertilizer, pesticide, and herbicide. The One-way ANOVA test is shown in table 4.15 below.

Table 4.15 One-way ANOVA comparing the means of fertilizer, herbicide, and pesticide application by adopters and non-adopters

Dependent variables	Mean		Significance
	Q-GAP Adopters	Non-adopters	
Season 1 Fertilizer	2.27	2.15	.083
Season 2 Fertilizer	2.29	2.19	.161
Season 1 Herbicide	1.92	1.98	.458
Season 2 Herbicide	1.93	2.00	.428
Season 1 Pesticide	3.146	4.023	.001
Season 2 Pesticide	3.038	3.836	.002
Season 1 N input	1,261.25	1,570.01	.002
Season 2 N input	1273.30	1,561.29	.005
Pesticide input cost	328.85	454.35	.117
Herbicide input cost	168	177.45	.597
Fertilizer input cost	882.45	1066.89	.014
Total input cost	1379.38	1698.69	.004

When the means of rice farming practices are compared, pesticide application frequency shows statistical significance for both seasons. This means that farmers who do adopt Q-GAP do change their practices. The problem from this table is how to identify the point in time farmers change their practice, whether it is before or after adoption of Q-GAP. As for the frequency of herbicide and fertilizer frequency of application, there is no difference between the two groups. However, when N-input from chemical fertilizer was compared by calculating the formula of chemical fertilizer and the amount applied, the amount of nitrogen was determine. The result showed that nitrogen inputs between the two groups are different with statistical significance for both seasons. The implication for this data is that even though the frequency of chemical fertilizer application for both group is not different, there is a difference in terms of N input from chemical fertilizer, which means that some farmers may use other practices instead of chemical fertilizer application. As mentioned in literature review, Q-GAP rice recommends 3 times of fertilizer application and N input ranged from 860 to 1,400. The farmers who are first time adopters are staying within the recommended range at 1261 and 1273, while non-adopters are over by this range at 1570 and 1561. Some of the farmers interviewed are applying organic fertilizer, compost, and liquid nutrients instead of chemical fertilizers.

Input cost also reveals interesting information. Only fertilizer input cost showed statistical significance difference between the two groups. This result supported earlier result about differences in nitrogen amount. It showed that farmers are saving some cost of production against the conventional practices, which accords to the governments' advertisement campaigns. When all costs are compared as total input cost, there is certain statistical significance between the two groups. It implies the emphasis on cost reduction a farmer can receive after implementing appropriate use practices promoted by the Q-GAP. The research case in Sri Saket Province confirms also that input cost of farmers who adopts Q-GAP has lower input cost. Again, a limitation in this is that we cannot know exactly whether the farmer has tried to reduce their cost before or after coming into contact with Q-GAP. Further investigation is needed for this.

Finally, we can conclude that in terms of on farm management for herbicide, fertilizer, and pesticide, there is a difference in terms of the frequency of pesticide application, nitrogen input, fertilizer cost, and total cost of inputs.

4.5. Social and economic variables influencing continued adoption

The Nagelkerke R Square is at .469, which means that this regression can explain only 47% of the cases and the rest is unknown.

Table 4.16 Model Summary of binary regression of continued adopters

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
95.205[a]	.337	.468

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Table 4.17 Classification Table of binary regression of continued adopters

Observed		Predicted		
		Q-GAP Adoption		Percentage correct
		Not continued	Continued adopters	
Q-GAP continued adoption	Not continued	64	9	87.7
	Continued adopters	8	29	78.4
Overall Percentage				84.5

a. The cut value is .500

Table 4.18 Binary regression of continued adopters

Variables	B	S.E	Sig.	Exp (B)
Total rais	.568	.447	.203	1.765
Frequencies of government contact	.151	.099	.126	1.163
Rice training attendance*	.611	.693	.378	1.843
Household labour not in rice production	.400	.212	.059	1.492
Rice farming has impact on environment*	.005	.571	.993	1.005
Farmer gained yield increase*	1.209	.676	.074	3.349
Farmer gained cost reduction*	2.666	.676	.000	14.378
Future desire to do organic rice production*	.115	.593	.846	1.122
Age	.048	.031	.117	1.050
Frequencies of contact to government by rice farmer	-.395	.184	.032	.674
Household labour allocated to fertilizer application	-.495	.616	.422	.610
Having influential position in society*	-1.238	.634	.051	.290
Having land ownership (chanote)*	1.671	.637	.009	5.320
Constant	-8.619	2.639	.001	.000

*rice training attendance as compared to no attendance; perception that rice farming has impact on environment as compared to no impact; truth in increased yield as compared to no increased yield; truth in cost reduction compared to no cost reduction; desire to switch to organic rice in the future as compared to no desire; household labour allocated for fertilizer application as compared to hired service; having influential positions as compared to no influential positions; complete land ownership and partial land ownership as compared to all rent land.

An interesting factor from this table is on access to land, which shows that having complete ownership to land or having owned some part of the land has a positive statistically significant impact on adoption. This means on average, farmers who are continuing are land owners whether completely or partially. However, in the Central Region of Thailand, according to the permanent secretary to the Ministry of Agriculture and Cooperatives, statement in the Thai Rath online newspaper on April 16, 2013 that a survey of more than 5 million farmers nationwide shows that 45% of farmers are renting land for agriculture in which farmers in the central region make up the majority, followed by north, northeast, and south. In addition, a commentary by Dr. Wiroj Na Ranong on rice mortgage scheme, he suggested that price of rice can influence cost of production in that as price increases, cost of production also increases such as land rent fees and fertilizers, a simple economic theory explains this. Mr. Prasit Boonchue, President of Thai Farmers Association, expressed that land rent fees have increased from 800-1,000 to 2,000 baht (Channel 3 News, 2013). Therefore the conditions of poor farmers will not improve as the benefits will be transferred to land owners. Following this argument, the Q-GAP program could be experiencing similar effects from cost reduction in that more land owners are more attracted to the program because they are truly benefiting from it through cost reduction initiatives while land renters may not be too much interested as they know that even if they reduces cost of production, their land rent may increase and the benefits will be taken by land owners.

For the continued adopters, truth regarding cost reduction has a positive statistically significance impact on adoption. This variable shows that continued adopters do receive the benefit of cost reduction when adopting Q-GAP, again reflecting the expectations that farmers has from Q-GAP and proving the program's fulfillment of its advertisements. This means that farmers who are still interested to continue with the program do see the benefits of staying with cost reduction.

On the other hand, the frequency in which rice farmers contact government officers has a negative statistically significance impact on adoption. This means that the more that a farmer asked questions or discusses about the program, they tends to adopt less. As farmers learn more about the details of the program, for example about no price guarantee as some of the disadopters have mentioned, farmer may not be interested to continue. Furthermore, it is interesting to note that government contact for the continued adopters has no significance at this stage as continued farmers have knowledge of the program already.

Social positions in society have a negative statistically significant impact on adoption. This means that the higher the position you have, the less you are willing to continue with the program. It can be interpreted that farmers in higher positions are leaving the program. This is a worrying point if the government officials are using influential farmers in the area as a contact point for Q-GAP promotion.

4.6. Management practices of interviewed farmers: pesticide, herbicide, and fertilizer use of continued adopters

It is interesting in that the continued adopters apply more frequently the fertilizer that is statistically significant. This result corresponds more to the recommendations that at fertilizers should be applied 3 times for non-photosensitive rice variety. However, it is unexpected that the N input for continued adopters is a bit higher than the range recommended by the Q-GAP, which supposed to be from 860 to 1,400, while disadopters are lower than the recommendations. As for herbicide and pesticide application, it is the same for both groups.

Table 4.19 One-way ANOVA for continued adopters and disadopters

Dependent variables	Mean		Significance
	continued Adopters	Disadopters	
Season 1 Fertilizer	2.38	2.14	.013
Season 2 Fertilizer	2.41	2.14	.008
Season 1 Herbicide	1.95	1.96	.161
Season 2 Herbicide	1.95	1.98	.254
Season 1 Pesticide	2.934	3.284	.899
Season 2 Pesticide	2.973	3.068	.747
Season 1 N input	1498.92	1273.38	.455
Season 2 N input	1488.03	1300.81	.835
Pesticide input cost	268.47	283.43	.806

Herbicide input cost	156.21	191.36	.167
Fertilizer input cost	1047.24	881.38	.181
Total input cost	1471.91	1356.18	.389

4.7. Types and names of agrochemicals used by interviewed farmers

Common chemical fertilizers used are with the formula 16-20-0 and urea 46-0-0. Some farmers applied other formulas such as 18-12-14, 16-8-8 30-0-0, 18-8-8, 15-15-15, 18-4-5, 16-16-16, or 12-0-3. Some farmers use organic fertilizer mixed with chemical fertilizer, others use homemade compost.

Pesticides types and brand names varied. Abamectin was the most common pesticide found being used by Ayutthaya farmers. For others, the list below shows different brand names and common names of the chemicals used. The table below shows pesticides found during interview.

As for herbicide, the most common chemical names is butachlor. There are also various brand names and common names. The table below show different pesticide, fungicide, and herbicide found during interview with toxicity classification by the World Health Organization (WHO) as well as Q-GAP recommendations.

Table 4.20 Agrochemicals used by Ayutthaya farmers, which has been found during the interview (Department of Rice Thailand)**,** (Ministry of Agriculture and Cooperative Thailand, 2011)**, and** (World Health Organization , 2009)

Commercial name	Active ingredient	Type	Toxicity by WHO	Q-GAP recommendations
Skyfin	Avermectin group - Abamectin	Insecticides	Not classified	Not prohibited, not recommended
starkle dinotefuran	Nitromethelene group -Dinotefuran	Insecticides	Not classified	Not prohibited
Pelnum	Pyridine azomethines group – pymetrozine	Insecticides	Not classified	Not prohibited
Prosand	Carbosulfan	Insecticides	Not classified	Recommended for use
Addbomb	Chlorpyrifos Organophosphorus group	Insecticides	Class II, Moderate	Recommended for use
Fenobucarb	Fenobucarb Carbamate group	Insecticide	Class II, Moderate	Not prohibited
Padan	Cartap hydrochloride, Thiocarbamate group	Insecticide	Class II, Moderate	Not prohibited Banned in most places
Cypermethrin	cypermethrin	Insecticide	Class II, Moderate	Not prohibited

Actara 25 WG	Thiamethoxam/neonicotinoid group	Insecticide	Moderate	Not prohibited
Trichlorfon	Trichlorfon	Insecticide	Class II, Moderate	Not prohibited
Dicrotophos	Dicrotophos	Insecticide	Class Ib, Highly hazardous	Not prohibited
Dupont	Chlorantraniliprole / diamides group	Insecticide	Class U, unlikely to present acute hazard in normal use	Not prohibited
IBfos 40	Chlorpyrifos organophosphorus group	Insecticide	Class II, Moderate	Recommended for use
Prodigee 240 SC	Methoxyfenozide	Insecticide	Not classified	Not prohibited
Assand	Fipronil; phenyl pyrazole insecticide group	Insecticide	Class II, Moderate	Recommended for use
Trebon 20	Etofenprox	Insecticide	Class U, unlikely to present acute hazard in normal use	Recommended for use
Eraphos	Triazophos	Insecticide	Class Ib, Highly hazardous	Not prohibited
	Deltametrin	Insecticide	Not classified	Not prohibited
Quinalphos	Quinalphos	Insecticide	Class II, Moderate	Not prohibited
Padan-Mibzine 6 G	Cartap hydrochloride + isoprocarb	Insecticide	Class II, Moderate Class II, Moderate	Not prohibited
Napam	Buprofezin	Insecticide	Class III, Slightly	Not prohibited
Harmuley	Difenoconazole and propiconazol (15% + 15% W/V EC)	Fungicide	Class II, Moderate Class II, Moderate	Not prohibited
Anthracole (BYER Crop Science)	Propineb	Fungicide	Class U, unlikely to present acute hazard in normal use	Not prohibited
J-ben	Carbendazin Benzimidazole group	Fungicide	Not classified	Recommended for use
Miminee01	Bispyribac-sodium Pyrimidinyloxybenzoic group	Herbicide	Class III, Slightly	Not prohibited
Goalsafe	Butachlor + safener	Herbicide	Class III, slightly	Not prohibited

	Chloroacetanllide group			
Ricemax	Clomazone Isoxazolidinone group	Herbicide	Class II, Moderate	Not prohibited
Meepro + quota	Propanil Butachlor	Herbicide	Class II, Moderate Class III, Slightly	Recommended for use
Griffin	Clomazone + bispyriback-sodium	Herbicide	Class II, Moderate Class III, Slightly	Not prohibited
Glysophate	Glysophate	Herbicide	Not classified	Not prohibited
Sofit	Pretilachlor	Herbicide	Class U, unlikely to present acute hazard in normal use	Not prohibited
Dara amine	2, 4-D Dimethylammonium	Herbicide	Not classified	Not prohibited

Beuvoria was found to be one of the products promoted by the Rice Research Center and are being used by some farmers. Beuvoria is a fungi that naturally destroys pests. Other products claimed to be environmentally friendly used by farmers such as AntiBug for pests, D-save (fermented plant extract) for rice disease, Tinger Bioclean for mold and bacteria on plants. Not much information was found on the label of these bottles.

And, there are other chemical products being used by farmers as 'hormones' or enhancers for different periods of rice productions. Some samples are shown in the below table.

Table 4.21 Other agrochemical products used by the farmers as mentioned during the interview

Other products	Purpose	Active ingredient	Toxicity (WHO)
Apsa – 80 (Amway)	All purpose spray; improves capacity of pesticide, herbicide, etc.	No information	
IBfos	Prevent and get rid of plant diseases	Carbendazim	Class U, unlikely to present acute hazard in normal use
Orthiwa	No information	Azoxystrobin + difenoconazole	Class U, unlikely to present acute hazard in normal use Class II, Moderate
Namizin	Plant diseases	Validamycin	Class U, unlikely to present acute hazard in normal use

4.8. Rice variety used by interviewed rice farmers

Various rice varieties were found to be used by the farmers. Some farmers are using two or more rice varieties in the same season, but in different plots. The table below shows the type of rice varieties used by Q-GAP adopters and non-adopters. For further information on the rice variety see Appendix III. Most farmers in the Central Region such as in Ayutthaya Province use non-photosensitive rice varieties or high-yielding varieties, which is unlike in the Northeast region where some are traditional varieties and photosensitive rice.

Table 4.22 Rice varieties used by interviewed farmers

Season 1	Adopters	Non-adopters	Season 2	Adopters	Non-adopters
Phitsanulok2	38	20		29	13
กข31	35	13		36	11
กข47	45	19		48	17
กข41	25	11		33	23
suphan 1	16	7		10	7
กข 35	1	0		2	0
pathum	5	0		8	1
กข 23	1	0		0	0
51	5	3		5	4
กข 35	0	1		1	0
suphan 60	1	1		1	0
กข 29	3	6		6	3
cp111	1	0		1	0

4.9. Disadoption reasons

With limitation of time and resources, further model to investigate factors that explains disadoption was not done. However, some farmers gave brief description about why they have stopped continuing to participate in the Q-GAP program. Some have said that they don't have enough man power to frequently visit their fields to check and use natural spray to prevent pest outbreaks. Also, many have said that price is not persuading because Q-GAP rice are not sold separately from other type of rice. Some have said that the Q-GAP is difficult and with no motivation on price, a farmer doesn't see the reason to switch. Some farmers felt that they were left out because no extension officers came to visit them. Others feel that the water surrounding their farm is unclean as it is located near factories, so they feel that they cannot get the certificate.

Other farmers feel that they have tried for one or two months, but they have to revert back to use chemical pesticides because of hoppers breakout. So, they feel that when they first tried and it doesn't work, they did not continue to try, but automatically revert back to the same practice.

Most of them didn't feel that bookkeeping was a challenge for them or natural disasters like drought or flood.

Chapter 5

Conclusion and Recommendation

The concerns for international food safety and its program calls for a better understanding about how it plays out at the national level for food producing countries. Though 'carrot and stick' measures in terms of mandatory regulations and programs are established, voluntary initiatives offer alternatives for improved standards and practices with the benefit of gaining better market or sales. An example of voluntary initiatives includes the GAP or good agricultural practice as promoted by the Thai Ministry of Agriculture and Cooperative, which has been investigated in this study on rice farmers. Any type of programs relating to the changes in production practices for the betterment of environment, food safety, or food quality cannot be successful without the involvement of producers or farmers and their willingness to take risks and changes of behaviors.

This study investigates the factors and patterns of Q-GAP adoption by rice farmer in Ayutthaya Province that glimpses on the profile of the adopted farmers and if any of their practices is significantly different from other farmers who does not adopt. After successful adoption, each farmer receives a certificate. This study pooled 250 individuals from available comprehensive list of Q-GAP farmers being promoted with Q-GAP program. Social, economic, and environmental factors that potentially explain adoption and non-adoption were investigated in the first analysis through binary regression. Comparing of means of dependent variables on adoption and disadoption was also investigated. A similar analysis was made the second time for continued adopters and disadopters.

Though skeptics questioned the effectiveness of Q-GAP program, based on this study similar factors to adoption were found as compared to other sustainable technologies that contributed to adoption. Education is one such factor, which has been confirmed repeatedly as a character of early adopters. Other factors included knowledge of neighbors being involved in the program, non-governmental channel about the program, and smaller farm size. Preliminary farmers who are willing to adopt has expectations on cost reduction and expectation on price in their mind as a benefit they will receive after adopting. As for the farmers who are willing to continue with Q-GAP adoption, the factor on access to land has an important role to play. It was found with significance that farmers who own their land completely or partially are more willing to continue with adoption.

It is possible that farmers who owned land are more secure and they are the true benefiters of their land. Farmers who are renting land are less secure to changing environment. For example, in effects of the rice mortgage policy of the government have caused the land rent and other farming materials to increase in which farmers renting land are directly affected by this. As land owners realize that price for rice has increased, they also increase land prices. Similarly, with Q-GAP program, had cost reduction been achieved by farmers, the price of land could increase when land owners became aware of this. Therefore, full benefits will not be achieved by farmers who are renting land. Realizing this, farmers who are renting land are less willing to adopt this type of program as they know that the benefits will be acquired by other parties. A better policy that can control and regulate 'land rent prices' could potentially improve and encourage farmers who are renting land to adopt this certification.

As for the management of land in terms of pesticide, herbicide, and fertilizer application, there are some significant different practices between adopters and non-adopters. Initial adopters tend to be able to reduce costs, apply lower frequencies of pesticide, and less nitrogen input with the value ranged according to the recommendations by the Q-GAP program (860-1,400). As for continued adopters and disadopters (second stage), there are not many differences, except for frequencies of fertilizer application where continued adopters are applying more frequently according to the recommendations by the Q-GAP program, however when nitrogen input has been calculated, there is not significant differences between continued adopters and disadopters; however, continued adopters went over the recommended range. Therefore, Q-GAP program adoption explaining nitrogen input factor remained inconclusive.

In a way, one can view the Q-GAP as different from other initiatives such as sustainable rice agriculture, organic rice farming, or other 'go green' programs in that it tries to promote appropriate use of agrochemicals and fertilizers rather than a complete switch of technologies. A complete switch would have been impossible in the mass rice productions and low quality of rice in the central region of Thailand and from this research rice farmers that adopted Q-GAP are not significantly looking forward to switch to organic rice production. The study shows that this program has some potential to be implemented in the central region as we do see that the practices of farmers are not entirely uniform, some are using less pesticide and chemical fertilizers than others and are successful in reducing costs even with low quality rice. Q-GAP program can be effective in steering the rice farmers to practice safer production of rice to the environment, consumers, and farmers themselves if clear benefits are communicated. It should be noted that the central regions conditions are very different from that in the Northeast region in which high quality of rice are produced and are targeted towards niche market like organic farming. As research in the Northeast region showed, farmers expected that price for Q-GAP produce should be guaranteed as a motivation for farmers to adopt it widely. At the moment, Q-GAP production price is not guaranteed and the main campaign using appropriate level of chemicals thereby achieving cost reduction. With varying environmental conditions and needs of farmers between the two regions, the policy to support farmers in the two regions should be different.

Support from the government is certainly not enough; buyers of rice produce should also be involved. Q-GAP certification ensures that farmers are producing with good practices and it is a certificate that communicates directly to buyers. However, there should be a link from this certificate to other eco-labeling labels at the higher value chain if possible.

Since this study focused primarily on adoption, more research and survey is needed on disadoption in the central plain to get a better understanding of the situation. A similar survey can be conducted by following closely on disadopters on a yearly basis to determine when adopters become disadopters.

The major limitation for this study is that it is not a dynamic study; the study only captures farmers' practices at a certain point of time. This means that we do not know whether the farmers who adopted Q-GAP were already practicing cost reduction and appropriate use of agrochemicals or not and for how long. In the same token, this research cannot answer whether those continued adopters who are applying more nitrogen input had started to reduce their nitrogen input than before Q-GAP adoption and are still trying to reduce. For those who disadopoted, they were not followed on a yearly basis to determine the time they disadopted.

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Appendix I. Q-Gap Rice label in Thailand

Under the Thai rice quality policy, the GAP or good agricultural practice was developed and is now implemented by the Department of Rice. It is the standard developed to confirm the standard quality of rice produced according to the guideline and to promote trustworthiness in rice product on the following dimensions:

1. on farm level hygienic conditions
2. management of agricultural equipment and tools
3. management of input factors
4. production control and practice
5. bookkeeping and document control

The rice "quality" in this context refers to the production of rice without chemical residues. It also refers to the production of rice with no more than 5% of off type rice for normal white rice and no more than 2% of off type rice for Hom Mali rice. And, for quality milling, to have head rice and whole kernel of no less than 34% for white rice and 36% for Hom Mali rice.

There are a total of 7 standards for the Q-Gap rice, which includes measures from inputs to post-harvest.

Q-Gap rice certification criteria

Criteria	Standards
1. Water sources	Water used must not be from environment that is at risk from hazardous substances
2. Plot area	An area that does not have hazardous substances that could cause residues or contaminate harvest
3. Using hazardous substances in agriculture	- should follow the suggestions from Department of Rice or Department of Agriculture or advise from labeling that is formally registered with Department of Agriculture - do not use hazardous substances for agriculture in the registered list - for exports of rice, do not use hazardous substances that the importing countries banned
4. Quality management in production before harvest 4.1 Production to prevent off type rice	Harvested and threshed wet and dry paddy rice and must have the following quality: White rice: cannot have off type rice of more than 5% and this amount should have no more than 2% of red kernels Hom Mali rice: no more than 2% off type rice and no more than 0.5% red kernel Evaluation is based on choosing appropriate seeds

	quality and from a trustworthy source Cultivation management and taking care to reduce volunteer rice and off type rice and has bookkeeping
	White rice: number of off type head rice should be no more than 3% Hom Mali rice: number of off type head rice should be no more than 2%
4.2 Pest and weed prevention and risks from pest	- survey rice pests - prevent pest and weeds with efficiency and appropriate approach according to Department of Rice - if using chemical pesticide, then follow number 3 - produce should not have or more than 10% sight of phytopathy and pests destruction
5. Harvest and post-harvest practice 5.1 Management for rice to have good milling	 Harvest in appropriate time to have good quality rice with whole kernel and head rice according to measures in agriculture and food product standards for each rice by harvest during: - rice spike age is 25-35 days after flowering day - rice spike is still in mature grain stage, which rice kernel is yellowed no less than ¾ of rice spike
5.2 Harvesting and threshing	- tool used in harvesting, container and approach to harvesting should not have an effect on product quality and must harvest carefully to prevent off-type rice in case of threshing with machine or combine harvester, it must be cleansed and must be careful in preventing off type rice. If the machine was harvesting other type of rice before, then it must be cleansed first.
5.3 Humidity of rice and its reduction	- if not selling as wet paddy rice, then humidity condition must be lowered within 24 hours post-harvest - Reducing humidity should not cause broken kernels - Humidity reduction should not be no more than 15% for selling and 14% for storing
6. Transportation, storage, and product collection	- equipment, container, and vehicle used in transporation and storage should be clean, can prevent contamination from hazardous substances and other residues that risks food safety as well as preventing off-type rice - production storage facility should be hygienic, clean, and with good air flows, which can protect it from being contaminated and off-type rice

	- approach to storage and storing produce should not destroy the produce and at risk to off-type rice as well as prevention from other pests in storage facility - in case rice producer produces more than one type of rice, the rice farmer should have preventative measure for off-type rice
7. Bookkeeping and information records	- should have records related to 1. seed sources 2. water sources 3. land preparation 4. management of off-type rice 5. survey and losses from pests and management 6. use of agriculture hazardous substances 7. harvest and thresh rice 8. Humidty reduction of wet and dry paddy rice 9. Paddy rice container and storage 10. Sources of produce
	- produce in the middle of transportation and storage should have information labeling its sources that can be traced later

Appendix II. Questionnaire for interview

Questionnaire for research on Q-GAP.
Note: Questionnaire was translated into Thai by the author.

I. Profile of head of farming operation/decision maker

FARMER NO.______

<table>
<tr><td>Name</td><td colspan="7"></td></tr>
<tr><td>Last name</td><td colspan="7"></td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Sex</td><td colspan="7"></td></tr>
<tr><td>Age</td><td colspan="7"></td></tr>
<tr><td colspan="2">Are you the main person that makes decision on the farm? (e.g. pesticide and fertilizer use, and harvest)</td><td>Yes</td><td colspan="5">No

Specify:</td></tr>
<tr><td>How many people are living under your house?</td><td>Total</td><td colspan="3">How many people bring additional income?</td><td>How many works on farm with you?</td><td colspan="2">How many children?</td></tr>
<tr><td>How many years did you attend schools?</td><td></td><td colspan="3">Can you read and write?

Yes</td><td colspan="3">No

Does any body in your house can read or write?</td></tr>
<tr><td>How long have you been a decision maker for rice production?</td><td colspan="7"></td></tr>
<tr><td>How many plots do you have?</td><td colspan="3">Plot 1</td><td colspan="3">Plot 2</td><td>Plot 3</td></tr>
<tr><td>What is the area of each plot?</td><td colspan="3">Rais</td><td colspan="3">Rais</td><td>Rais</td></tr>
</table>

What type of land ownership? (Full Title NS3 Chanote, Sor Por Kor 4/01, leased, neither owned nor leased, rice contract)				
In the last year season, what area did you grow rice and other crops (if any)?	Crops	Season 1	Season 2	Season 3
		rais	rais	rais

II. Adoption of Q-GAP

Have you participated in a training on Q-GAP?	Yes Year ________	No
Have you tried registering for the Q-GAP rice (following the training)?	Yes, I tried Year________	If you tried, did you received the Q-Gap? Yes No, reasons:
	No, I did not try	
Are you currently participating in Q-GAP program this year?	Yes When did you start?_______	No When did you stop participating? Year____________ Why did you stop?

Are all your rice plots under Q-GAP currently?	Yes	No, how much is not under Q-GAP?
		Why do you have plots that are not under Q-GAP?

III. Rice farming behavior

Have u ever sent soil samples for test?		Yes/no
		If yes, what is the type of soil you have? What is its condition?

Pesticide application						
	Q-GAP plots Adopters			Non Q-GAP plots Adopters/non-adopters		
	S1	S2	S3	S1	S2	S3
In the last season, did you use pesticide on rice?						
In the last season, how many times did you apply pesticide on rice?						

What type of pesticide did you use and how much did you pay per plot?	Brand Cost	Brand Cost	Brand Cost	Brand Cost	Brand Cost	Brand Cost
Labour used to spray pesticide on rice per time	Number of laborers: Rais: Cost:					
How long does it take to get from your house to pesticide shop?						
Do you use any other way to prevent pests and disease in rice field?						

Herbicide application						
	Q-GAP Plot Adopters			Non Q-GAP Plot Adopters/non-adopters		
	S1	S2	S3	S1	S2	S3
In the last year seasons, did you apply herbicide on rice?						
In the last season, how many times did you apply herbicide on rice?						
What type of herbicide did you use and how much did you pay per plot?	Brand Cost	Brand Cost	Brand Cost	Brand Cost	Brand Cost	Brand Cost
Labour used to put herbicide on rice per time	Number of laborers: Rais: Cost:					

How long does it take to get from your house to herbicide shop?						
Do you use any other technique to prevent weeds or other herbs?						
Synthetic fertilizer application						
	Q-GAP Plot Adopters			Non Q-GAP Plot Adopters		
	S1	S2	S3	S1	S2	S3
In the last season, did you use chemical fertilizer on rice?						
How many times did you apply fertilizer in general?						
Which brand of fertilizer did you use?						
Formula (N, P, K)						
How many bags of fertilizer did you use for the plot? Specify the fertilizer bag quantity						
How much did one bag of fertilizer cost?						
Labour used to put fertilizer on rice per time	Number of laborers: Rais: Cost:					
How far is the fertilizer shop?						
Do you use manure?	Yes			No		

Do you know any shop that sells organic fertilizer?	Yes	No

What is the rice variety that you cultivate in the last season?	Season 1	Season 2	Season 3
How much did you receive from buyers in the last year seasons?	Season 1	Season 2	Season 3
What is the total yield of rice in each season?	Season 1	Season 2	Season 3

For Q-GAP Adopters

Did you change any practices after adopting Q-GAP for those who adopted in one point in time?	

Changed practices with Q-GAP certification	If you have adopted the Q-GAP in the past, how many changes did you make after you have applied for the Q-GAP? (land, pesticide use, fertilizer use, water management, use of machinery, etc.)	
		Did you reduce chemical fertilizer use?
		Did you reduce pesticide use?
		Did you reduce herbicide use?
		Did you have to change the way you manage water?
		Did you have to make a new bookkeeping?
		Did you purchase new equipments to comply with Q-GAP?
		Did you use more labour for Q-GAP?
		Other changes:

Can you summarize the price of different inputs and sales of rice?	Adopters			Non-adopters		
Ton of rice sold	s1	s2	s3	s1	s2	s3

Cost of pesticide						
Cost of herbicide						
Cost of fertilizer						

IV. Social and economic conditions

Do you receive income from other type of work not related to rice?	Season 1	Season 2	Season 3
Are you affiliated with community organization, government organization, or other organizations?			

Are you affiliated with community organization, government organization, or other organizations?	Yes	Cooperatives Community Rice Enterprise
	Yes	Others, specify:

Have you ever attended any training on rice farming in general?	Organizer: Topic: Organizer: Topic:	

Do you think that rice farming is having an impact on the environment?	Yes	No

V. Interaction with Q-GAP

How did you learn about Q-GAP?	Visit by government officer	Documents given on Q-GAP
	Attended a training	Neighbors
	others	
Have you ever contact a government officer for an advice on Q-GAP	Yes How many times?	No
How many times did government officer contacted you on Q-GAP		
Do you know anyone else who have or is currently participating in Q-GAP program?	Yes How many?	No

VI. Rice sales and Q-GAP

Potential buyers			
After you harvested your rice, what do you do with the rice harvest? (drying, sell it immediately, or others)			
Who are the major buyers of your rice? (Millers, Rice brokers, Neighbors, local community)	Q-GAP Plot	Non Q-GAP plot	
Does your buyers ask to see the Q-GAP certification?	Yes Who?		No

Do you get any support from buyers for Q-GAP? (i.e. knowledge, training,)	Yes What: Who:	No
Do you get better price from your buyers for Q-GAP?	Yes Who:	No

Expectations and the truths on Q-GAP	When you registered, did you think that yield will be improved after adopting Q-GAP guideline? Yes No
	Did your yield improved? Yes No
	When you registered did you think that rice price would be better with Q-GAP label? Yes No
	Did you sell your rice with a better price with Q-GAP label?
	When you registered, did you think that you would reduce cost of production? Yes No
	Did you reduce cost after following the guideline of Q-GAP? Yes No
	When you registered, did you think that you would sell rice easier with Q-GAP label?
	Did you sell Q-GAP rice easier?
Future expectations	Do you expect yourself to be producing rice in the future? Yes No
	Do you think you will try to get other rice certification in the future? (IFOAM, ACT, organic rice, etc.)

Questionnaire for Disadoption

1. When did you adopt the Q-GAP program and when did you stop?
2. Why did you stop?
3. Do you think that the weather such as drought and flood has become unpredictable to you?
    a. Yes
    b. No

4. When you adopted the Q-GAP, you have to do bookkeeping, were you able to complete the bookkeeping every year ?
    a. Yes
    b. No
5. Was bookkeeping too time-consuming for you given what you get out of the program?
    a. Yes
    b. No
6. During the time that you were Q-GAP certified, did you take any other employment opportunities with salaried payment?
    a. Yes
    b. No
7. When you first started the Q-GAP program on your farm, how much land did you allocate to Q-GAP? What about second and third year?

Appendix III. Rice variety and information

Rice Variety	Basic information
Phitsanulok 2	Non-photosensitive lowland rice with 119-121 harvesting days
กข 31 (Pathumthani 80)	Non-photosensitive lowland rice with 111-118 harvesting days
กข 47	Non-photosensitive lowland rice with 104-112 harvesting days
กข 41	Non-photosensitive lowland rice with 105 harvesting days
Suphan Buri 1	Non-photosensitive lowland rice with 120 harvesting days
กข 35	Photosensitive lowland rice with harvesting period in November to December
Hom Pathum or Pathumthani 1	Non-photosensitive lowland rice with 104-126 harvesting days
กข 23	Non-photosensitive lowland rice with 125 harvesting days
Suphan 60	Non-photosensitive lowland rice with 120-122 harvesting days
กข 29 or Chainat 80	Non-photosensitive lowland rice with 99 harvesting days in off-season and 103 harvesting days in in-season