A Study on the Characteristics of Farmers' Management Capability in Thailand

(タイにおける農家の経営能力の特徴に関する研究)

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Dedication

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Acronyms and abbreviations

AE	Allocative Efficiency
ALRO	Agricultural Land Reform Office
BAAC	Bank for Agriculture and Agricultural Cooperatives
CRS	Constant Return to Scale
DEA	Data Envelopment Analysis
DOAE	Department of Agricultural Extension
EE	Economic Efficiency
FAO	Food and Agricultural Organization of the United Nations
GDP	Gross Domestic Product
Ha	Hectare
JICA	Japan International Cooperation Agency
JIRCAS	Japan International Research Center for Agricultural Sciences
KDML105	A variety of the non-glutinous rice, namely "Kaow Dowk Mali 105"
Km	Kilometer
Km^2	Square kilometer
LDD	Land Development Department
OAE	Office of Agricultural Economics
Mm	Millimeter
NE	Northeastern region
N-P-K	Nitrogen (N), Phosphorus (P), Potassium (K)
NSM	New Slack Model

NSTDA	National Sciences and Technology Development Agency
Rai	A measurement unit of land is used in Thailand, which 1 rai is equal to 0.16 ha or 0.395 acre
RD6	A variety of the glutinous rice, namely "Kor-Khor 6)
RD15	A variety of the non-glutinous rice, namely "Kor-Khor 15"
S.D	Standard Deviation
SE	Scale Efficiency
SFA	Stochastic Frontier Analysis
TE	Technical Efficiency
VRS	Variable Return to Scale

Chapter 1
Introduction

1.1 Background of the study

Farmers in developing countries are frequently exposed to uncertainties in weather, prices and diseases, and suffer under the constraints of farm resources (Kahan, 2013). Moreover, changes in agriculture following the introduction of new technologies, more borrowing or leased capital, new marketing alternatives, government policies and changing economic environments have both positive and negative effects on agricultural production (Marks, 2011; Kay et al., 2016). This means that farms, like other small business, require good management to survive and prosper (Kay et al., 2016).

Researchers, government officers and non-governmental, and international development organizations have attempted to identify and promote appropriate solutions for farmers by developing major agricultural inputs, farm resources and technologies (Olson, 2004). Improving the management capability of farmers is one way to do this, and has been extensively described in the literature (e.g., Rougoor et al., 1998; Olson, 2004; Solano et al., 2006; Hansson, 2008; Nuthall, 2009[a]; Phelan and Sharpley, 2012). Improvements to management capability help farmers to operate their farms effectively and to increase farm production and profitability efficiently (Zimmerman et al., 2006; Kay et al., 2016).

Management capability refers to a farmer's ability to apply existing knowledge and skills to operate a farm effectively, to deal with problems and opportunities in the optimal way and to produce the required outcomes (Rougoor et al., 1998; Pillay, 2008; Trinder, 2008). In addition, management capability forms the fourth major agricultural input, and plays a key role in the efficient management of other three primary inputs: land, labor and capital (Olson, 2004; Nuthall, 2009[a]). The efficiency of production of a farm's land, labor and capital is critically dependent on the management capability of farmers (Nuthall, 2009[a]). Accordingly, it is necessary to address the concept of improving farmers' management capability as a basic goal of policies and strategies for developing farm practice and increasing the production and competitiveness of farmers (Phelan and Sharpley, 2012).

The concept of improvement to farmers' management capability has received considerable attention in both developed and developing countries in recent decades (e.g., Solano et al., 2006; Hansson, 2008; Phelan and Sharpley, 2012; Alcedo et al., 2013). In this regard, while studies are available which examines the management capability of farmers around the world, there is still no clear evidence of the various aspects of the management capability of farmers in Thailand. Even though Thai farmers, particularly small-scale farmers, are likely to require good management capability to thrive under the changes of agricultural and economic sectors. Small-scale farmers in rural areas cannot rely on an agricultural income for their living and must allocate their time between on-farm and off-farm activities (Jonathan and Sakunee, 2001; Barnaud et al., 2006; Andreas et al., 2012). The small-scale farmers also face several problems in terms of agricultural production such as labor shortages, limited farm sizes, scarcity of water, poor soil fertility, outbreaks of pests or diseases, increasing prices for inputs (e.g., land, and fertilizers) and wages, lower level of capital and high interest rates on loans, and declining and fluctuating farm-gate prices (FAO, 2001; Jitsanguan, 2001; Andreas et al., 2012; Jessop et al., 2012; Kahan, 2013; Thida and Ito, 2008; Winai, 2015).

Therefore, it is crucial to address the improvement of the management capability of farmers as a primary goal of policies for development of farmers in Thailand, as in other countries. To improve this management capability, it is necessary to obtain a good understanding of the characteristics involved (Rougoor et al., 1998). To take this, there is a need to clearly examine the personal characteristics (e.g., abilities and skills, attitudes and perceptions, and biography) and decision-making processes that represent the management capability of a particular farmer (Rougoor et al., 1998, 1999; Hansson, 2008; Ali and Kumar, 2011; Kahan, 2012; Vukelić and Rodić, 2014; Kay et al., 2016).

In terms of personal aspects, the study of a farmer's ability is an essential first step, since farmers use these abilities every day in carrying out farm activities and making appropriate decisions to make their farm successful (Nuthall, 2006, 2010[a]). An examination of farmers' attitudes is also important, since these play a central role in a farmer's behavior and decision-making during the gathering of information and adoption of new technology (Willock et al., 1999[a]; Edwards-Jones, 2006). The study of the decision-making of farmers provides a broader understanding of their vocational behavior (Willock et al., 1999[a]). To understand farmers' decision-making, an examination of the processes of searching for information and making decisions is required (Nuthall, 2001).

Furthermore, in order to see the impacts of the management capability of farmers on farm operation, an estimation of farm outcomes needs to be considered. As these outcomes provide empirical evidence which can be used to improve management capability (Solano et al., 2006; Kahan, 2012, 2013). When evaluating farm outcomes, the measurement of production efficiency provides an important method of obtaining a farm's potential output. This measurement can determine the gap between the potential and actual production of the farm (Umanath and Rajasekar, 2013; Kay et al., 2016). This can also provide a better understanding of the farm's production and the causative factors involved in this.

1.2 Objectives of the study

The main objective is to study the characteristics of the management capability of farmers in Thailand. The motives for focusing on this are to clarify the present characteristics of the farmers' management capability and determine out potential ways of improving this capability for farmers so that they may thrive within the constraints of the agricultural and economic sectors. The specific objectives of this study were to:

- measure the level of farmers' managerial ability and to find out the determinants related to farmers' ability;
- clarify the farmers' attitudes toward farm management and farm development;
- study the farmers' processes of searching and sharing agricultural information within their social networks;
- describe the farmers' decision-making in agricultural problems and illustrate the decision events of individual farmers through case studies; and
- evaluate the outcomes of farm performance, measured in terms of technical, allocative and economic efficiencies, and identify the factors associated with increasing efficiency.

1.3 Thesis structure

To achieve the main objective, this study is organized into nine chapters (Figure 1.1). This chapter has presented the general background to the study and a statement of the research problems. Chapter 2 provides a brief account of the definition of management capability, followed by an overview of the definitions of farmers' abilities, farmers' attitudes and perceptions, decision-making processes and production efficiency. Chapter 3 is devoted to the detailed description of the research framework and research questions used in this study. It also includes an overview of agriculture in Thailand and in Northeast region, and a description of the area under consideration.

In order to achieve the objective of understanding the characteristics of the management capability of farmers, this study emphasizes the examination of two major aspects: personal characteristics and decision-making processes. Chapters 4 and 5 present the results with regard to the personal aspects of farmers. Chapter 4 describes the levels of farmers' managerial ability as measured using the managerial competency test. This chapter also describes the results of the determinant contributing to improvements to this managerial ability. In Chapter 5, the discussion focuses on clarifying the farmers' attitudes towards farm management and farm development.

The findings from the investigation of farmers' decision-making processes are presented in Chapters 6 and 7. Chapter 6 addresses the processes used by farmers in searching for and sharing agricultural information within their social networks. Chapter 7 illustrates the farmers' decision-making processes regarding agricultural problems. This chapter also describes the decision experiences of individual farmers through case studies.

Chapter 8 describes the impacts of management capability on farm performance. This chapter gives a measurement of farm outcomes through an evaluation of technical, allocative and economic efficiencies, including a determination of the factors associated with the level of technical and allocative efficiencies. In the final chapter (Chapter 9), a summary of the major findings, conclusions and implications are presented, as well as suggestions for further research.

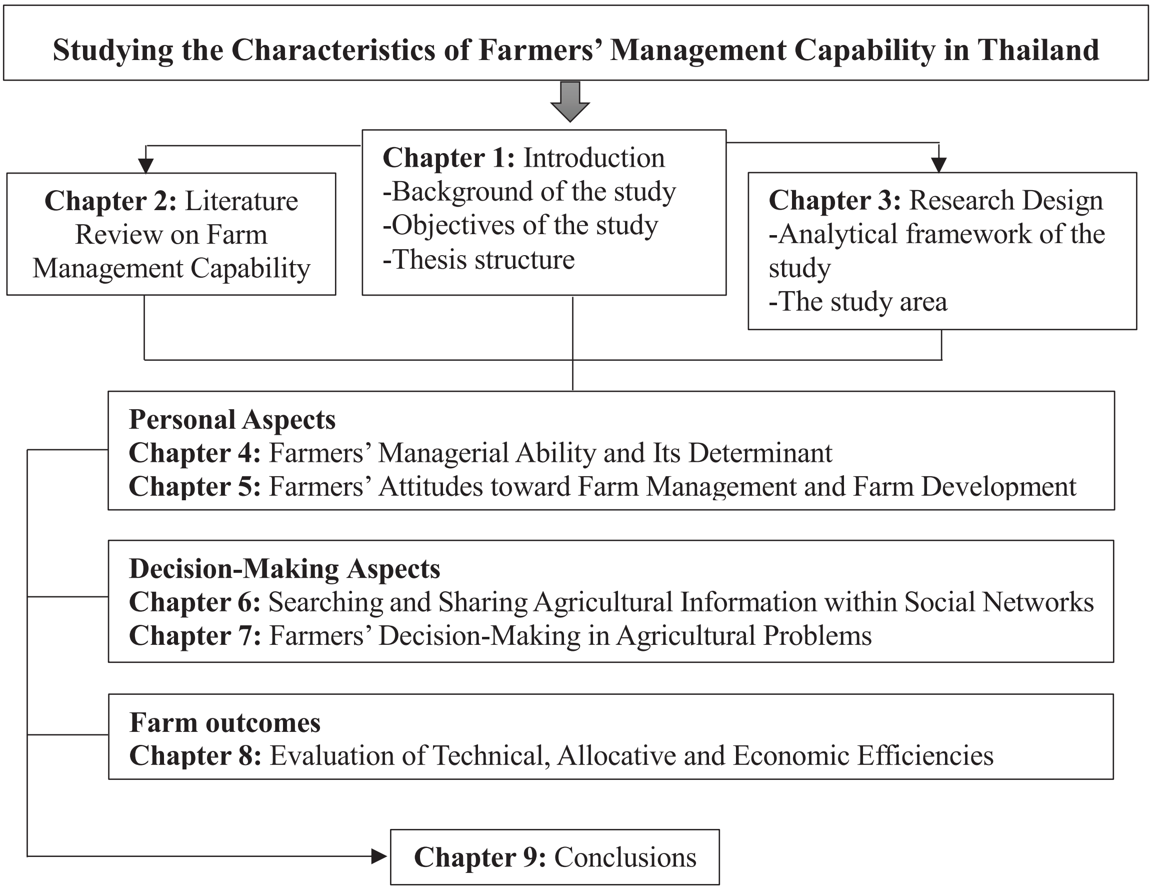


Figure 1.1 The structural organization of thesis

Chapter 2
Literature Review on Farm Management Capability

To better understand the concept of farmers' management capability, it is essential to define what it means. Thus, the purpose of this chapter is to give a brief account of the definition, looking at farmers' managerial abilities, farmers' attitudes toward farm management and farm development, decision-making processes, and farms' production efficiency (farm outcome).

2.1 Definition of farm management capability

Capability has always been seen as a key function of managing the agricultural production of land, labor and capital (Olson, 2004; Nuthall, 2009[a]). However, there is still no clear approach to studying farm management capability, as past studies have used several methods.

Before these processes are discussed, the terms involved need to be defined. Accordingly, "farm management" is concerned with the decisions that affect farm profitability (Castle et al., (1987) cited in Rougoor et al., 1998). Kay et al. (2016) determine that farm management helps the farmer make the right decision in farming, which can be divided into two major categories: strategic and tactical management. Smallwood and Ulrich (2004) state that capability is the collective skills, abilities and expertises of an organization; they suggest that for social issues using "capability" and "ability", which refers to an individual's leadership, is more appropriate than using "competence."

Trinder (2008) proposes managerial capability is "the ability to apply knowledge and skills to produce a required outcome." Pillay (2008) determines that managerial competencies (capabilities) are sets of knowledge, skills, behaviors and attitudes that enable managers to perform their work effectively and efficiently. Moreover, Chong (2011) states that management competency is the ability to effectively manage varying perceptions and the expectation of others and competencies refer to the performance of personal, task-specific and social interaction.

With regard to the definitions of farmers' management capability, Portugal and Jones (1984) define management capability as the capability of farmers to be informed, evaluate new alternatives, take decisions, master technology and interact with other sectors of society. Rougoor et al. (1998) determine management capability as "having the appropriate personal characteristics and skills, which include drives and motivations, abilities and capabilities as well as biography, to deal with the right problems and opportunities in the right way." In addition, Rougoor et al. (1998) propose a concept of management capability with two aspects: personal (drives and motivations, abilities and capabilities, and biography) and decision-making (planning, implementation and control). Alcedo et al. (2013), who studied farmers' capacity for livestock production in the Northeastern Philippines, state that capability is "the ability of farmers to raise farm outcomes in the proper production and management practices". Furthermore, Vukelić and Rodić (2014) reviewed previous research and defined farmers' management capacities as the "possession of appropriate personal characteristics and capacities of farmers to cope with specific problems and opportunities at the right time and in the right way."

According to the concept of Rougoor et al. (1998), some researchers have tried to understand the correlations between biography aspects and the efficiency of the future development of decision-making support systems, technology transfer activities and developing management practices, particularly in terms of livestock farms. For example, Rougoor (1999), applied the framework of management capacity to analyze the relationship between dairy herd management, milk production and economic performance and found that a farmer's attitudes and personality had an influence on farm management and milk production. Solano et al. (2006) studied the impact of biographies (personal aspects) and decision-making profiles on management and performance; they pointed out that decision-making profiles for sharing decisions, maximizing income and revenue, and obtaining information from multiple sources had the highest impact on management practices, whereas farmers' biographical profiles (personal aspects) had no significant bearing on farm performance. Hansson (2008) found that personal aspects (e.g., values, attitudes, perceptions, locus of control, education, experience and age) are more important for the economic efficiency of dairy farms, both in long and short term than managerial (or decision-making) aspects (i.e., searching for information, planning, forecasting and evaluating, and responsibility).

2.2 Farm managerial ability of farmer

To improve farmers' management capabilities, studying personal aspects with reference to their abilities is important. This is because the farmers' managerial abilities are used every day while performing farm activities (Nuthall, 2006). Moreover, Nuthall (2010[a]) defined managerial ability as a farmer's skill at making the right decisions and implementing them for a successful farm. The literature shows that the farmers' managerial ability is important for them to develop their management, practice and production.

However, despite many articles and textbooks on farm management describe the importance of managerial ability, it is still interesting to consider how to develop programs for improving farmers' managerial ability. Even though previous studies have examined aspects of farmers' personal characteristics such as age, education and farming experience, their actual abilities and capabilities are rarely explicitly examined, as they are more difficult to qualify and assess (Nuthall, 2009[a]).

To find potential ways to improve farmers' managerial abilities, many researchers have created measurement approaches for clarifying them, despite the difficulty in qualifying and accessing the information. As a result, numerous measurement techniques (e.g., cognitive, noncognitive and technical skills) have been developed in recent decades. Among these measurements, cognitive and noncognitive ability tests are widely used to measure farmers' actual managerial abilities.

Several studies involving the educational and agricultural sectors have measured the managerial ability of farmers using cognitive and/or noncognitive concepts aimed at better understanding and finding potential ways for improvement (Table 2.1). For example, Nel et al. (1998) defined competency (ability) as the individual characteristics related to criterion-referenced effective management and/or performance in a job and they determined eight dimensions of competency: communication, maximization of achievement, initiative, individual leadership, analysis, judgement, planning and organizing, and motivation. Nuthall (2001, 2002, 2006, 2009[a], 2009[b], 2010[a], 2010[b], 2011) attempted to determine the best way to measure farmers' managerial ability through reviewing its basic and potential improvements using psychological concepts. Nuthall (2006, 2009[a], 2010[b]) determined that a basic concept of managerial skills (or abilities) included managerial attributes (e.g., observation, planning, recording, introspection and communication), personal attributes (e.g., personality, intelligence, motivation, judging people, confidence and taking risk) and entrepreneurial skills (e.g., information seeking, negotiation, forecasting, control belief, risk factors and consideration).

Furthermore, Allahyari et al. (2011) analyzed farm management skills in poultry production enterprises in Iran through splitting farm managerial ability (competencies) in nine skills, including planning and goal setting, accountancy and finance, marketing, seeking for information, resource mobilization, risk orientation, communication and technical skills. They suggested that marketing and information-searching skills should be improved by promoting extension services such as training programs. Gaurav and Singh (2012) found that cognitive ability has a positive relationship with farmers' educational and financial management in rural India, of which mathematical ability contributed to a higher financial aptitude and debt literacy. In 2015, Frese and coauthors determined that the noncognitive abilities of female farmers in rural Malawi were significantly associated with cash crop adoption.

On the other hand, some studies have used a set of farmer demographics or production practices as a proxy variable for unobserved managerial ability. For instance, Ford and Shonkwiler (1994) used financial, dairy and crop management as proxies of unobserved managerial ability, finding that dairy management was an important determinant of a farm's financial success. Alvarez and Arias (2003) used economies of scale (technical efficiency) as a proxy for managerial ability, indicating that increasing the farm size with a fixed managerial ability is related to diseconomies of scale.

Table 2.1 Summary key approaches of three major ability tests

Cognitive ability (IQ) tests	Noncognitive ability tests	Technical skill test
-Literacy test (i.e., reading & comprehension (e.g., word knowledge and/or vocabulary test, paragraph comprehension); reasoning ability (e.g., Raven progressive matrices, picture classification); writing)	**-Emotional quotient** (EQ) (e.g., self-esteem, locus of control, self-awareness, self-management, motivation, empathy) *(Cunha et al., 2005; Heckman et al., 2006, 2007; Borghans et al., 2008; Boyatzis, 2008; Pillay, 2008; Nuthall, 2010; Brunello and*	**-Knowledge tests** (e.g., recognition techniques/ practices, timing, knowing how to perform, scientific understanding) *(Laajaj and*

(Harcher et al., 2002; Heckman et al., 2006; Keenan et al., 2008; Nuthall, 2010; Brunello & Schlotter, 2011; Williams et al., 2011; Glewwe et al., 2013; Laajaj and Macours, 2015)	*Schlotter, 2011; Glewwe et al., 2013; Goleman, 2014; Laajaj and Macours, 2015)*	*Macourse, 2015)*
-Short-term memory (e.g., arithmetic, digit span) *(Harcher et al., 2002;Colom et al., 2004; Boyatzis, 2008; Nuthall, 2010; Frese et al., 2015)*	**-Big five personality traits** (i.e., introversion, openness, agreeableness, conscientiousness, emotional stability) *(Borghans et al., 2008; Frese et al., 2015; Laajaj and Macours, 2015)*	
-Mathematical tests (e.g., math problem, practical calculation) *(Colom et al., 2004; Heckman et al., 2006; Nuthall, 2010; Brunello and Schlotter, 2011; Gaurav and Singh, 2012; Glewwe et al., 2013; Frese et al., 2015)*	**-Managerial competencies** (or abilities) (e.g., planning, organizing, leading, problem analysis, management style, timing ability, communication, risk aversion) *(Nel et al., 1998; Nuthall, 2002, 2006, 2010; Pillay, 2008; Allahyari et al., 2011; Chong, 2011, Ferruz et al., 2012)*	
-Processing speed (e.g., finding A's, coding speed) *(Harcher et al., 2002; Colom et al., 2004; Heckman et al., 2006)*	**-Social competencies** (e.g., social awareness, relationship management, social desirability, social skill, leadership, teamwork) *(Borghans et al., 2008; Boyatzis, 2008; Brunello and Schlotter, 2011; Goleman, 2014)*	

2.3 Farmers' attitudes and perceptions toward farm management

Attitudes play an important role in farmer behavior, so the study of farmers' attitudes has received considerable attention in recent decades (Edwards-Jones, 2006). For example, the study of Willock et al. (1999[b]) determined that farmers' attitudes are classified as risk taking (aversion), innovative, environmental, satisfaction with farming, stress and attitudes toward legislation. Willock et al. (1999[a]) also pointed out that attitude toward risk aversion has major importance in the study of farmers' decision-making. Waiblinger et al. (2002) stated that farmers' attitudes and characteristics are important factors in successful production (milk yield). Nuthall (2002, 2006, 2009[a]) studied farmers' personalities (or attitudes) through providing 25 statements of farm managerial styles and asking farmers to rate their attitudes on a five-point-Likert scale (true to not true). Palacios (2005), who studied farmers' attitudes toward sustainable agriculture in Japan, found that young farmers' attitudes to the model of sustainable agriculture can support Japanese agriculture's sustainability. Sadati et al. (2010) examined the attitudes and perceptions of Iranian farmers on the concept of sustainable agriculture by giving 24 statements of attitudes and using a five-point-Likert scale (strongly disagree to strongly agree). Samah et al. (2012) discovered Malaysian contract farmers' attitudes using 14 statements on sustainable agriculture and a five-point-Likert scale to capture farmers' attitudes, with ranging from strongly disagree to strongly agree. Haneishi et al. (2014) analyzed the effects of farmers' attitudes toward risks in farm decision-making and rice production, finding that farmers' risk attitudes significantly affected rice production (yield). Odongo and Muhua (2015) determined farmers' attitudes from six components: information focus, negative, change orientation, passive dependence, heritage and resigned unhappiness.

2.4 Decision-making process

The managerial decision-making process has recently been given more attention, both in theoretical studies and in empirical research explaining the differences in farm outcomes (Trip et al., 2002). To clearly explain the variation in farm outcomes, studies should include aspects of the managerial decision-making process (Wilson et al., 2001) because decision-making is the principal activity of farm management (Kahan, 2013).

To formulate an effective policy to support the development of farm production, we need a better understanding of why different farmers make different decisions on farm strategy (Hansson and Ferguson, 2011). Studying farmers' decision-making provides a broader understanding of their vocational behavior (Willock et al., 1999[a]). To comprehend farmers' decision-making capabilities, we should not only study decision-making processes but also clearly examine the processes of learning and thinking about information (Nuthall, 2001).

In a review of literature on decision-making processes, Öhlmér et al. (1998) proposed a strategic model of decision-making processes that includes four steps: problem detection, problem definition, analysis and choice, and implementation, which consists of four sub processes: searching and paying attention, planning, evaluating and choosing, and bearing responsibility. A number of empirical studies have worked similarly on decision-making aspects, such as Rougoor et al. (1998), who suggested that aspects related to decision-making include planning, implementation and control. Solano et al. (2003) studied the role of personal information sources on the decision-making process. They describe the decision-making process in four phases: problem detection, seeking for problem solutions, seeking for new practices and opinion. In addition, Solano et al. (2001) determined that technology transfer activities (e.g., extension and training) is one of the factors involved in the decision-making, They found that operational decisions are mostly related to farm labor and family members, while technical decisions are related to technical advisors and family members. Olson (2004) stated that decision-making processes are usually considered as a set of eight steps: determining values and setting goals, problem detection, problem definition, observation, analysis, development of intension, implementation and responsibility bearing. Bolfíková et al. (2010) studied manager's decision-making with five key dimensions of organizational learning: system thinking, personal mastery, mental models, building shared visions and team learning. Hansson and Ferguson (2011) indicated the factors contributing to decision-making processes included decision structure, business structure, cognitive structure and network structure. Ali and Kumar (2011) studied farmers' decision-making processes by examining three stages: production planning, cultivation practices and post-harvest management, and marketing. Kahan (2013) determined that the basic decision-making process in risk management includes setting goals and objectives, looking at the different ways to achieve goals, evaluating opportunities and alternatives, selecting opportunities and alternatives, planning for implementation and evaluating selected opportunities. Perea et al. (2014) stated that decision-making can be viewed as a process with three elements: information access (information, record, advisers, dedication), use of information (record use, information use), and formality of the decision-making process (objectives, planning, evaluation). Kay et al. (2016) proposed the decision-making has seven steps: identifying and defining the problem or opportunity, identifying alternative solutions, collecting data and information, analyzing the alternatives and making a decision, implementing the decision, monitoring and evaluating the results and accepting responsibility.

2.5 Farm production efficiency

Farmers with different managerial capabilities (e.g., abilities, attitudes, biography, and decision-making) usually achieve different outcomes despite similar farm environments, climate, technology choices and economic conditions (Barkema, et al., 1999; McBride and Johnson, 2006). Hence, to successfully develop farmers' capabilities and farm production, it is crucial to investigate farm outcomes.

When evaluating farm outcomes, measuring production efficiency provides an important way to attain a farm's potential output, which can determine the gap between the potential and actual production of the farm as well as the give attention to farmers' technology and resource endowment (Umanath and Rajasekar, 2013; Kay et al., 2016). This result also provides a better understanding of the production and the causative factors.

To estimate production efficiency, three concepts proposed by Farrell (1957) are commonly used: 1) technical efficiency: measuring the ability of farmers to produce either maximum potential outputs with a given set of inputs or at a minimum cost with continual producing a given number of outputs; 2) allocative efficiency: the ability of farmers to use inputs in optimal proportions with respective prices; 3) economic efficiency: the capacity of a farm to produce a predetermined quantity of output at minimum cost for a given level of technology (Farrell, 1957) or the capacity to choose an optimal level and structure of inputs and outputs for maximum profit (Coelli et al., 2005). Furthermore, as the farm size increases, labor and machinery can be better adjusted; the optimal size is reached when marginal returns equal marginal costs (Rajčániová, 2004). Accordingly, scale efficiency is also usually considered to better understand whether a farm's scale is efficient.

Technical and allocative efficiency can be measured by two main approaches:

input-oriented and output-oriented. Input-oriented (minimum cost) is used to examine "whether and to what extent it is possible to reduce its input (s) without reducing the output (s)", whereas an output-oriented (maximum profit) approach determines "what is the maximum output producible from the same input bundle" (Ray, 2004).

Furthermore, Farrell (1957) determined that there are two main methodologies for measuring technical efficiency: a parametric method (stochastic frontier approach or SFM) and a nonparametric method (data envelopment analysis or DEA). These two methods differ in two ways: 1) the parametric method (SFM) is stochastic and attempts to distinguish between the effects of noise and the effects of inefficiency, whereas nonparametric (DEA) is deterministic and under noise inefficiency (Porcelli, 2009); and 2) the parametric method (SFM) requires the assumption of a functional form, while the nonparametric (DEA) one does not (Coelli, 1995). In addition, one advantage of the nonparametric method (DEA) is that it can analyze multiple inputs and outputs in different units (Coelli et al., 2005).

According to the concepts of estimating production efficiency, previous researchers have widely suggested measuring production efficiency in terms of crop and/or livestock farms aimed at developing farm management practices, improving farm production and increasing farm efficiency. Some examples of the empirical findings on estimation of the technical efficiency of crop farms are available in the literature. Wilson et al. (2001) found that wheat farmers in eastern England still have room to increase technical efficiency, finding the farmers' education and managerial experience had a significant influence on the farm efficiency results. Binam et al. (2004) mentioned that it is necessary to increase the technical efficiency for smallholding farmers in the slash and burn agricultural zone of Cameroon, indicating that credit, soil fertility, social capital, farm location, and extension services were significantly related to improving technical efficiency. Villano and Fleming (2006) studied technical efficiency in rice production in the Philippines, finding that there is a high level of technical efficiency estimates, which can be attributed to the instability of farming conditions in a rain-fed lowland environment. The significant factors influencing efficiency were the area planted for rice, labor and the amount of fertilizer used. Idiong (2007) mentioned that rice farmers were not fully technical efficient and that education, membership of cooperatives/farmer associations and access to credit significantly influenced the positive efficiency. In 2007, Bozoğlu and Ceyhan determined that education, experience, credit use, women's participation in the farm and information were significantly associated with the technical efficiency of vegetable farms in Turkey. Dağistan (2010) suggested that wheat farmers should reduce input costs by 20% to increase technical efficiency and the efficiency level is mainly affected by farmer's education and farm size. Furthermore, Khai and Yabe (2011) indicated that the mean technical efficiency of rice farms was 81.6% and the factors associated with technical efficiency were intensive labor, irrigation and education.

Latruffe et al. (2005) found that livestock farms were more efficient technically and in scale than crop farms and they pointed out that education was a significant factor for technically efficient practices. Galanopoulos et al. (2006) indicated that there is ample potential to increase efficient utilization of inputs in domestic pig farming; the factors related to increasing this are the choice of insemination method, origin of the genotype, the feedstuff preparation system, the mortality rate of piglets and the size class. Aldeseit (2013) indicated that dairy farms in Jordan were not operating at an optimal size and a supporting extension service could help farmers improve their management practice and increase technical efficiency.

With regard to samples that investigate economic efficiency, i.e., allocative and technical efficiencies, in crop farms, Jha et al. (2000) stated that wheat farmers with large farms experienced more technical and allocative efficiencies than small farms. Coelli et al. (2002) measured costs and technical, allocative and scale efficiencies in Bangladesh rice farms, finding that rice farms' efficiencies were higher in the dry season than in the wet season. Moreover, farmers with better access to input markets and less off-farm work were more efficient than others. Dhungana et al. (2004) found that gender, age, education and family labor were significant in improving the efficiency of Nepalese rice farms. Haji (2006) looked at that the existence of substantial allocative and economic inefficiencies in vegetable production of smallholders in eastern Ethiopia, finding that assets, crop diversification, consumption expenditures and farm size had a significant impact on allocative and economic efficiencies, whereas asset, off/non-farm income, farm size, extension visits and family size were significant determinants of technical efficiency. Li et al. (2010) mentioned that smallholding farms participating in the Grain for Green program had substantial economic inefficiencies, finding that the determinant factors related to the levels of efficiencies were farm size, remittance, land tenancy, and land fragmentation. Mburu et al. (2014) indicated that wheat farmers were not fully efficient in technical, allocative and economic terms, pointing out that education, distance to extension advice and farm size had a strong influence the efficiency levels.

Bojnec and Latruffe (2007) determined that farmers with crops, dairy, livestock using own feed, fruit and forestry were fully technical, scale, allocative and economic efficiencies. Hansson and Öhlmér (2008) determined that to increase the economic, technical and allocative efficiencies for Swedish dairy farms, changing breeding and feeding practices was crucial.

In case of Thailand, for example, Krasachat (2004) indicated that the technical efficiency of rice farms in Thailand in 1999 was widely diverse suggesting an influence of the diversity of natural resources. Rahman (2009) stated that the average technical efficiency of Jasmine rice producers in northern and northeastern Thailand was 63%, pointing out that land, irrigation and fertilizers were significant factors. Shamsudin et al. (2011) found that the mean technical efficiency for rice farms in central Thailand was 85% and the significant factors related to technical efficiency were gender, farm experience, good agricultural practices, and cropping intensity. Srisompun and Isvilanonda (2012) found that the technical efficiency of rice production (88%) in 1987/88 had decreased to 72% by 2007/08; they suggested that crop diversification is one of the strategies that can be used to improve production efficiency. Srisompun et al. (2013) determined that the technical efficiency of three farming systems (i.e., rice monoculture, rice-sweet corn, and rice-peanut) did not make a significant difference, finding that fertilizers and seeds were important factors influencing rice production. Athipanyakul et al. (2014) found that the mean technical efficiency of upland rice production was 70% and pointed out that a significant factor affecting technical efficiency was the training program, which transformed knowledge on upland rice production. Overall, according to previous studies, most new agricultural technologies have only been partially introduced to improve production and increase efficiency.

Furthermore, there are only a few studies on other farm production systems. For example, Todsadee et al. (2012) investigated the technical efficiency of broiler farms, and Krasachat (2012) estimated the technical efficiency of durian farms.

Chapter 3
Research Design

3.1 Analytical framework of the study

In this study, we applied the conceptual framework of Rougoor et al. (1998) to clarify the aspects of farmers' management capability and generate appropriate ways to improve it. Management capability is the ability of farmers to manage farm practices and increase production as well as deal with problems, opportunities as and risks in the right way and at the right time. Farmers' management capability may affect farm outcomes such as economic, technical and allocative efficiency.

Based on the model developed by Rougoor et al. (1998) and on further aspects in the literature described previous (in Chapter 2), we identified the parts of analytical framework in Figure 3.1 to discuss the management capability of farmers. In this study, we presented descriptions of two concepts of management capability: personal and decision-making, including evaluation of farm outcomes.

Personal characteristics and skills include: socio-economic characteristics of the farmer and farm, farmer's managerial abilities and farmers' attitudes toward farm management and farm development. We measured farmers' managerial abilities using a noncognitive test, namely "managerial competence" and the questions were modified from a case study of Allahyari et al. (2011), including ideas make during our observations of the study area. We measured farmers' attitudes towards farm management, looking at attention paid to farming, openness to ideas, business orientation, financial risk, success in farming, satisfaction, emergent management, and stress behavior. To form the set-up questions, we adjusted some questions from the study of Nuthall (2009[a], 2006, 2002) and included our ideas.

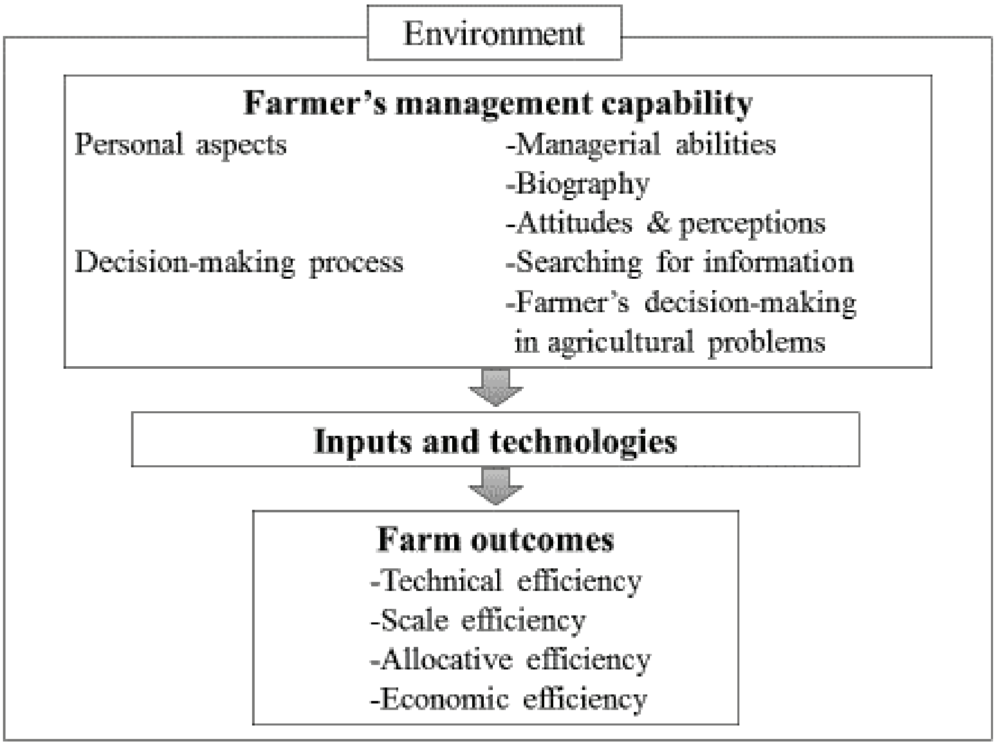


Figure 3.1 Analytical framework of the study

Decision-making aspects was described through representing a series of case studies. In this study, we examined farmers' decision-making, which focused on the processes of increasing knowledge by searching and sharing agricultural information within social networks, and the aspects of farmers' decision-making in agricultural problems through case studies of individual farmers. With regard to decision-making aspects, four key processes were used: detecting problem, defining problem, analyzing and choosing the potential solution to deal with problem, and implementation.

To measure farm outcomes, we estimated the technical and scale efficiencies of rice farms. We also measured economic and allocative efficiencies, including the technical efficiency of multiple crops (i.e., rice, sugarcane, cassava). Moreover, we identified the determinant factors of technical and allocative efficiencies to improve the efficiency of farms with multiple crops. In this study, we applied data envelopment analysis (DEA) approach to calculate the technical, scale and economic efficiencies through the DEA Online Software (http://www.deaos.com).

3.1.1 Research questions

Based on ideas in the literature discussed in chapter 2 and on simple logic, this study addresses five major questions:

1. What is the level of managerial ability of farmers, and what are the determinant contributing to farmers' ability?
2. What are the attitudes of farmers toward farm management and farm development?
3. How do farmers search for and share agricultural information within their networks?
4. What are the aspects of farmers' decision-making in agricultural problems?
5. What are the outcomes of farm management performance, measured in terms of production efficiency scores and the factors associated with improving efficiency?

3.2 The study area

3.2.1 Overview of agriculture in Thailand and in Northeast region

In Thailand, agricultural food production in particular-not only generates economic value, but also plays a key role in people's livelihoods and household finances (NSTDA, 2011). In 2012 the population of Thailand was estimated at 64.5 million people, with 23.7 million (37% of the total population) involved in the agricultural sector (DOAE, 2012). The total utilized land area of Thailand is about 321 million rai or 51.3 million hectares. Of this, 149 million rai (46%) are mainly used for agricultural activities. Of the total agricultural area, 68% is used for cultivating food crops, which in 2013 included 70 million rai of paddy land and 31 million rai allocated for upland field crops such as cassava, sugarcane and maize (OAE, 2014). However, the total contribution of agricultural production only accounted for 9% of Thai GDP; about 1.3% of Thailand's GDP comes from rice exports (Lee, 2015).

The Northeast is the largest region of Thailand, with a total of around 63.8 million rai (10.2 million ha) of agricultural land, divided into 42.7 million rai of rice paddies, 11.9 million rai of upland field crop and 4.3 million rai of orchard and perennial crops (OAE, 2014). Only around 6.3 million rai are irrigated even though government offices and international agencies are investing in and administering funds mainly with building water resources for rice and vegetable farming (Polthanee et al., 2014). Consequently, the majority of farmers in this region depend on rainfall. The mean annual rainfall in 2014 was 1,394 mm. and there were 101 rainy days (OAE, 2014).

In this region, the average holding of farmland is about 27 rai (4.3 ha) per household. Approximately 85% of farmers are small-scale (Barnaud et al., 2006), and their landholding tends to be less than 20 rai (World Bank, 2003, as cited in Nagayets, 2005). Most small-scale farmers live in rain-fed areas have inadequate supply of water and lack opportunities for market access (Andreas et al., 2012). These farmers mainly produce foods for home consumption then sell surplus products for a cash income. Rice is the major crop, followed by maize, cassava and sugarcane. The average annual cash income per household in 2011 was 140,565 baht from the agricultural sector and 99,666 baht from the non-agricultural sector (DOAE, 2013).

3.2.2 Description of the study area

This study was conducted in Khon Kaen Province, in Northeastern Thailand.

Khon Kaen is a central city of the upper Northeast and is about 445 km from Bangkok, the national capital. This province is bordered by Loei, Udonthani, and Nong Bua Lam Phu to the North, Kalasin and Maha Sarakham to the East, Nakhon Ratchasima and Buriram to the South, and Chaiyaphum and Phetchabun to the West. It consists of 26 districts and total land area is 10,886 km^2 (6.8 million rai), with about 4.6 million rai (68%) used mainly for agricultural production. The total population of the area was 1.7 million people in 2012, and about 552, 760 people (33%) were actively engaged in agricultural activities. For the economy, the total of GDP was 155,272 million baht in 2013, approximately 10.8% from the agricultural sector. The GDP per capita was 81,884 baht.

In terms of physical geography, the elevation of Khon Kaen is approximately 200-250 meters above mean sea level. The climate is influenced by both Northeast and Southwest monsoons. The Northeast monsoon occurs from November to February and brings a cold front, while the Southeast brings rain from April to September. The average annual rainfall of Khon Kaen Province during 2000-2013 was 1,290.5 mm, with a minor peak in 2008 (1,780.6 mm) and major peaks in 2005 (936.5 mm) and 2013 (943.1 mm) (Figure 3.2). The annual daily average temperature ranges between 19°C in January

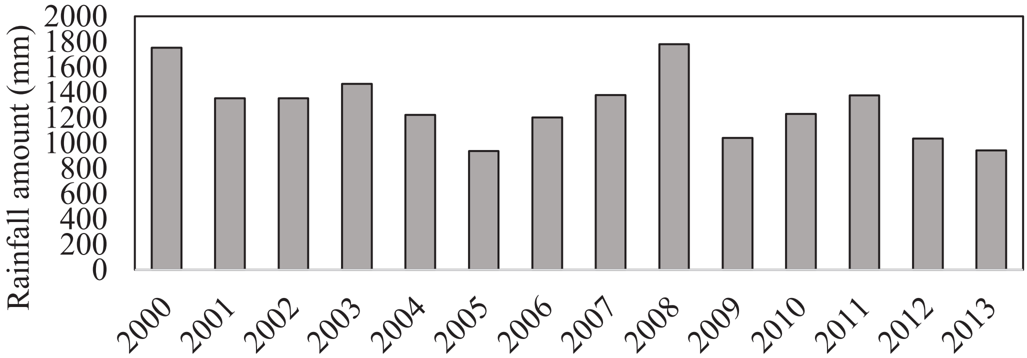


Figure 3.2 Rainfall amount and distribution pattern in Khon Kaen Province during 2000−2013

Source:Northeastern Meteorological Center (Upper Part), 2016 (winter) and 35°C in April (summer).

The data were collected from farmers living in two districts of the province's 26 districts: Nong Song Hong and Non Sila. In Nong Song Hong district (Amphoe), the villages (ban) in which our major farmer survey was conducted are Wang Thong and Wang Hin. We also interviewed farmers living in Kud Long and Nong Nam Kun, which are located in the district of Non Sila. These two districts are about 97 km from the city. The location of the two districts is shown in Figure 3.3.

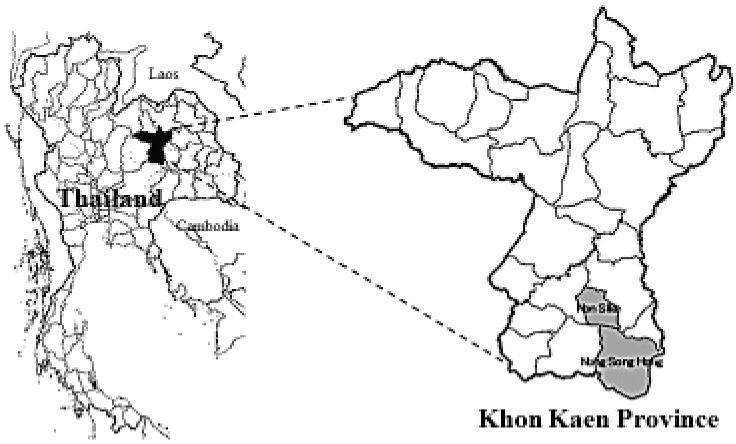


Figure 3.3 Location of Nong Song Hong and Non Sila, the study area, in Khon Kaen Province in Northeast of Thailand

These districts fall under the "Project for Revitalization of the Deteriorated Environment in the Land Reform Areas through Integrated Agricultural Development (Stage 1)", covering the four provinces of Khon Kaen (eight districts), Maha Sarakham (three districts), Sakon Nakhon (four districts), and Mukdahan provinces (one district). The Agricultural Land Reform Office (ALRO) and the Japan International Cooperation Agency (JICA) undertook this project to ensure food security and self-sufficiency for family farmers living in areas with scarce water resources during the period 1999 to 2011.

The conceptual framework of the project incorporated “sustainability,” “appropriate development model,” and “farmer participation” (Research and Development Institute, 2007). The project’s major activities included digging a farm pond, recommending adoption of “integrated farming” and “organic farming” by using participatory action research and rural appraisal (Research and Development Institute, 2007).

The primary objective of the farmers in these areas is to produce agricultural products both for home consumption and for cash income. As agricultural income plays a key role in household finances, farmers not only produce paddy rice but also cash crops such as sugarcane, cassava, vegetables and a variety of fruit. In particular, the farmers allocate about 63% of RD 6 (glutinous rice) and 50% of KDML105 (non-glutinous rice) for home consumption. Surplus rice can be sold when the need for an emergency cash income arises. Other crops like sugarcane, cassava, vegetables and fruit, are mainly (>90%) taken to the market to get cash income.

In general, farmers can grow rice once a year due to the dependence on rain water. Unfortunately, because of the irregular rainfall and scarce water supply in recent years, some farmers have not had enough rice for their home consumption so they have to buy and/or borrow rice from other farmers or their relatives, with an agreement to return the same amount of rice in the following year after harvest. In the meantime, farmers have shifted to increasing sugarcane and/or cassava planted areas to manage the risk of inadequate water supply for agriculture. Vegetables were grown for sale if farmers had enough water all year round.

Chapter 4
Farmers' Managerial Ability and Its Determinant

4.1 Introduction and specific objectives

In Northeast of Thailand, smallholders, particularly family based farms face with several obstacles such as scarce water in dry season, small-scale land for farming, risk and severity of disasters. Moreover, their bargaining power and access to high-value markets are limits, forcing them to accept the farm-gate offered by middlemen who are monopolistic in the local market and tend to exploit their position (Andreas et al., 2012). Farmers no more rely only on agriculture income and they have to allot their time between on-farm and off-farm jobs (Jonathan and Sakunee, 2001). As a result, it leads to more difficult for farmers to prosper their farming.

For the farmers thrive in these situations, developing farmers' management capability through improving their managerial ability is one of the alternative solutions (McLean-Meyinsse and Brown, 1994; Rougoor et al., 1998; Lawrence, 2011; Allahyari et al., 2011). As among four basic agricultural inputs (i.e., land, labor, capital, and management), managerial capability, including ability has the important role to manage effectively (Lawrence, 2011). Hence, if farmers improved their ability to manage the inputs of land, labor, and capital, their farm outputs may increase (Allahyari et al., 2011). This is because the farmers' managerial ability has relegated to adopt effective production technology in order to achieve maximum output vis-à-vis income and efficiency (McLean-Meyinsse and Brown, 1994; Nell et al., 1998; Rougoor et al., 1998; Allahyari et al., 2011; Lawrence, 2011).

Furthermore, to improve farmers' managerial ability, there are various determinants as changes in production patterns have occurred as new influencing factors.

In the past, even though many research have endeavored to determine factors associated with managerial ability such as age, level of education, experience, training, and source of labor (Rhone et al., 2008; Nuthall, 2011, 2009[b]; Lawrence, 2011; Yamohamadi et al., 2014), more efforts are needed because farmers in different locations and dynamic times appear to be influenced by different factors. In addition, a better understanding of the determinants would be useful to policymakers who aim at formulating policies that help farmers improve skills and farm productions.

From these aspects, it is essential to focus on management aspect of factors of production as call "managerial skills" because putting more effort into understanding the levels of managerial ability can be useful to improve farmers' ability (Nuthall, 2001). Moreover, attaining expertise to improve farmers' abilities is a necessary step to support farm household and agricultural production in Thailand.

Although the farm management ability is necessary for farmers, there is no study on farm management in Thailand and no information is currently available on farm managerial ability. Thus, the aim of this chapter was initiated to record the measuring levels of farm managerial ability of farmers and to identify the specific factors associated with managerial ability of farmers. This information will be used as the primary areas for future research.

4.2 Sample and data collection

A purposive random sampling technique was used to select farmers living in two villages, namely Wang Thong and Non Sa-At in August 2012. The total number of households in Wang Thong and Non Sa-At village are 165 and 217, respectively. Agricultural activities play a key role in household finances in the two villages. Rice production is the majority, followed by vegetables and sugarcane. The rice cultivation season usually starts in May (the end of dry season) and lasts for 4 months. The growing of vegetables such as cucumber, long bean, chili, and tomato usually starts after harvesting paddy rice. An average income of the farmers is at 30,000 baht per capita per year.

This study employed noncognitive test, called "managerial competency test" in regard to measuring farmers' managerial ability (as detailed in Table 2.1). The main instrument used for data collection was face-to-face oral interview with 37 farmers using a structured questionnaire. The questionnaire consisted of nine skills, which adopted from the case study of Allahyari et al. (2011). Five-point Likert scale was used for ranking the respondent's perspective to managerial ability, on the scale of 1 to 5 which corresponding with very low to very high. The reliability of questionnaire was calculated using Cronbach's alpha and was estimated at 0.97, thus making it highly reliability.

To identify the specific factors related to the managerial ability, farm managerial skills is a dependent variable. While *participation in group activities* (X_1), *household income* (X_2), *age of farmer* (X_3), *education* (X_4), *farming experience* (X_5), *rice-cultivated area* (X_6), *farm working hours* (X_7), and *planting vegetables in rice fields* (X_8) are considered as independent variables (Kirkley et al., 1998; Hellin et al., 2009; Lawrence, 2011).

4.3 Analytical methods

Descriptive statistics (mean and standard deviation) were utilized to indicate the perspective of farmer's managerial ability. In addition, to interpret on the mean score of the managerial ability, interval scale was applied, of which includes five scale levels: 1.00-1.79 (very low), 1.80-2.59 (low), 2.60-3.39 (moderate), 3.40-4.19 (high), and 4.20-5.00 (very high). Furthermore, Friedman test was carried out to indicate the statistically significant difference among means of sub-skills.

To identify factors contributing to farm managerial abilities, multiple linear regression was employed. The regression model specification is as follows (1):

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_8 X_8 + \varepsilon \quad (1)$$

where y is farm managerial competency level; $X_{1}, X_{2}, \ldots, X_{8}$ are independent variables. $\beta_{0}, \beta_{1}, \beta_{2}, \ldots, \beta_{8}$ are vector of parameters; ε is an error of the model.

4.4 Results and Discussion

4.4.1 Levels of farmer's managerial ability

A Friedman test was conducted to determine whether the mean ranks of skills and the means of sub-skills pertaining to farm managerial ability exhibited differences. The analysis results indicated that six skills contained sub-skills that exhibited significant differences: communicative skills, technical skills, planning and goal-setting skills, information-searching skills, accounting and financial management skills, and marketing management skills. These results implied that at least one of their sub-skills differed from the others. On the other hand, three skills (risk-oriented skills, resource mobilization skills, and decision-making skills) exhibited no significant difference in terms of mean sub-skill scores, implying that farmers' ability levels in these areas could be represented by average mean skill scores.

In this study, skills were compared based on mean sub-skill scores in order to describe farmers' level of managerial ability. This technique was used to present results in previous research, such as a case study conducted by Allahyari et al. (2011).

4.4.1.1 Risk orientation skills

As there was not different mean score of sub-skills, it implied that the farmers had a high level of ability in risk management skills with a total mean of 3.76 (Table 4.1). In terms of sub-skills, the farmers exhibited the highest score of ability in regards to quickly analyzing previously encountered risks. This sub-skill had a mean of 3.92, indicating a high ability level and the data points were spread out from the mean (S.D=0.7). On the other hand, the farmers exhibited the lowest score of the skills in regard to effectively managing financial and production risks. This sub-skill had a mean of 3.56, implying a high level of ability. The data point was not widely spread out from the mean (S.D=0.5).

Even though there were ranging from the lowest to the highest scores of sub-skills of risk management comparing among five sub-skills, all of them were ranked in the high ability levels (3.40-4.19). These results indicated that the farmers in this study area had the high skills to manage risks and uncertainties on their farm management.

Table 4.1 The average levels of risk-oriented skill and sub-skills

Sub-skills		Friedman test	
		Mean (S.D)	
Risk-oriented skills		**3.76**	χ^2 = 7.639, p-value =0.106
1	Ability to quickly analyze situation/risk that have never faced before	3.92 (0.76)	
2	Ability to create saving, and financial support when it is necessary	3.88 (0.60)	
3	Ability to predict and develop strategies to face dangerous conditions	3.80 (0.87)	
4	Ability to solve and manage about risks of input and product prices	3.64 (0.76)	
5	Ability to effectively managing financial and production risks	3.56 (0.51)	

Source: Survey data in august 2012

4.4.1.2 Resource mobilization skills

For resource mobilization skills, the total mean of 3.77 suggested that the farmers had a high level of ability in resource mobilization skills (Table 4.2). The farmers exhibited the lowest score of ability in regard to choosing technologies and methods for making efficient use of resources (M=3.72, S.D=0.7), but this score indicated at the high level of ability. Overall of resource-mobilized skills, the results indicated that farmers had the high skill level to manage effectively on farm resources and to use efficient technologies that lead them to finish working early.

Table 4.2 The average levels of resource-mobilized skill and sub-skills

Sub-skills		Friedman test	
		Mean (S.D)	
Resource mobilization skills		**3.77**	χ^2 = 0.792, p-value = 0.673
1	Ability to complete activities in the best possible time, shortest cycle time and maximum performance	3.84 (0.62)	
2	Ability to use input with minimal cost to get the maximum efficiency	3.76 (0.78)	
3	Ability to choose technologies and methods that make efficient use of resources	3.72 (0.79)	

Source: Survey data in August 2012

4.4.1.3 Decision-making skills

Decision-making was defined as a person's ability to confidently decide upon the best option for achieving the farm goals whether food sufficiency or maximum profit or both. The total mean for decision-making skills was 3.80, indicating a high level of ability (Table 4.3). In this area, the farmers exhibited the highest score of ability in regards to drawing on agricultural recommendations from advisors such as trainers, researchers, and soil doctors (M=3.92, S.D=0.7), its score indicating a high ability level. This implied that the training program and advice from the staff efficiently improved farm management among the farmers.

Although the mean score of the ability to rapidly analyze the situations, which farmers did not face so far, was the lowest, this score addressed in the ranged of the high level of ability (3.40−4.19). A possible cause of the high ability level was that the farmers managed their farm at a level of family farm so all decision-making were created by the major family labor working on farm. As a result, the farmers could improve their skills from frequency using their mine that leaded them confidential making decision.

Table 4.3 The average levels of decision-making skill and sub-skills

Sub-skills		Friedman test	
		Mean (S.D)	
Decision-making skills		**3.80**	χ^2 = 2.126, p-value = 0.713
1	Ability to use good agricultural recommendations from advisors such as trainers, researchers and soil doctors	3.92 (0.70)	
2	Ability to use best management operations on farming activities	3.84 (0.62)	
3	Ability to make a good decision about new technologies to use or be accepted	3.76 (0.83)	
4	Ability to quickly identify and correct manufacturing problems and the principles to solve the problems	3.76 (0.78)	
5	Ability to rapidly analyze the situations which farmer do not face so far	3.72 (0.84)	

Source: Survey data in August 2012

4.4.1.4 Communicative skills

Communicative skills were considered vital for farmers as it enabled farmers to connect with buyers for trade. As the data analysis (Table 4.4) indicated that the farmers exhibited the highest scores of ability in regards to creating a positive and good relationship with buyers and sellers, and obtaining cooperation from employees, with means of 4.20 (S.D=0.4) and 4.20 (S.D=0.5), respectively. Both of the sub-skills indicated in the very high ability level, and the data points of both of these sub-skills (S.D) were close to the mean.

In the meantime, the farmers exhibited the lowest score of ability in regards to considering the opinions and perspectives of others in the management unit (M=3.52, S.D=0.8). This mean score implied the ability in the high level. One possible explanation for this was that farmers relied on their own knowledge and experience. Consequently, they did not consider the opinions and perspectives of people, who had not clearly demonstrated successful outcomes.

Overview of the results suggests that the farmers in this study area had the high level of communicative skills as most of them often communicated due to selling their farm products with buyers and/or collectors.

Table 4.4 The average levels of communicative skill and sub-skills

Sub-skills	Friedman test	
	Mean (S.D)	
Communicative skills	**3.89**	χ^2 = 36.232, p-value = 0.000
1 Ability to create a positive and good relationship with buyers and sellers	4.20 (0.41)	
2 Ability to get good cooperation from the employee	4.20 (0.50)	
3 Ability to establish good, clear, exact and honest communication with others	4.08 (0.49)	
4 Ability to communicate with others about problems to achieve the desired result and the finding ways to solve them	3.96 (0.73)	
5 Experience and ability to transfer knowledge to new people who is beginning for working in farming	3.84 (0.69)	
6 Ability to assist neighbor to improve their skills and abilities	3.80 (0.76)	
7 Ability to create fit between job requirements and skills of their employee	3.72 (0.79)	
8 Ability to listen to their comments and suggestions to improve the performance	3.72 (0.79)	
9 Ability to consider others opinion and perspective in the management unit	3.52 (0.82)	

Source: Survey data in August 2012

4.4.1.5 Technical skills

Analyzing data (Table 4.5) indicated that the farmers exhibited the highest scores of ability in regards to developing and maintaining the qualitative (color, shape, and taste) and quantitative (size, heavy weight) features of products, with a mean of 4.04 (S.D=0.7), and improving soil construction before cultivation, with a mean of 4.04, (S.D=0.8). Both of these scores indicated at a high level of ability. However, as implying by the S.Ds of both skills, data were spreading out from the mean.

On the other hand, the farmers exhibited the lowest score of ability in regards to managing and developing equipment for controlling pests and weeds (M=3.60, S.D=0.5), meaning in a high ability level. This attributed to the accessibility of agricultural stores and farmers' frequent use of chemicals for controlling both pests and weeds.

All of technical sub-skills were ranked in the high level, it implied that the farmers had access to advantage techniques to manage such soil constructions, water systems, and pests and weeds.

Table 4.5 The average levels of technical skill and sub-skills

Sub-skills	Friedman test	
	Mean (S.D)	
Technical skills	**3.82**	χ^2 = 18.351, p-value = 0.003
1 Ability to develop and keep good qualitative and quantitative products	4.04 (0.79)	
2 Ability to improve soil construction before cultivation	4.04 (0.89)	
3 Ability to manage water systems over a production period	3.96 (0.73)	
4 Ability to get experience and new information from attending training programs	3.64 (0.81)	
5 Ability to use natural and organic cultivation systems	3.64 (1.11)	
6 Ability to manage and develop equipment for controlling pests and weeds	3.60 (0.58)	

Source: Survey data in August 2012

4.4.1.6 Planning and goal setting skills

Planning was defined as the skill to create a framework for operating a farm enterprise, facilitating efficient farm management. Table 4.6 shows that farmers exhibited the highest score of skill in regard to planting rotation crops on their own farmland, with a mean score of 3.72, meaning a high level of ability. However, the data point of this sub-skill was substantially spread out from the mean (S.D=0.9).

Farmers exhibited the lowest score of skill in regards to predicting the required input rate over a production period, with a mean of 3.16 (S.D=0.6), indicating in a moderate level of ability. The possible reason for this was that the farmers did not produce commercially or use substantial inputs so this skill was rarely used or practiced. Not only the skill to predict the required input rate ranged in the moderate level but also the skill to harvest products the best time when the price higher (M=3.36, S.D=0.9) and the skill to develop production program and to identify production targets in the short and long term (M=3.28, S.D=0.6). A possible cause was that the price of agricultural products were fluctuation all year round so it forced farmer difficulty to develop plan for harvesting in the best time. Moreover, agricultural production still depended on the climate that it sometime was unpredictable. Based on the results (Table 4.6), the moderate levels of three sub-skills of planning and determining the goal were required to improve to the high level.

Table 4.6 The average levels of planning and goal setting skill and sub-skills

Sub-skills		Friedman test	
		Mean (S.D)	
	Planning and goal setting	**3.46**	χ^2 = 16.990, p-value = 0.030
1	The ability to plant rotation crops on the own farm land	3.72 (0.94)	
2	Predicting and estimating the income from production over a production period	3.68 (0.95)	
3	Ability to set schedule activities in the short and long term	3.52 (0.92)	
4	Predicting and estimating production costs over a producing period	3.48 (1.00)	
5	Predicting and estimating production rates over a producing period	3.48 (1.00)	
6	Ability to provide a program for hard and difficult conditions and following it	3.44 (0.77)	
7	The ability to harvest products the best time when the price higher	3.36 (0.91)	
8	Ability to develop production program and to identify production targets in the short and long term	3.28 (0.61)	
9	Ability to predict the required input rate over a production period	3.16 (0.62)	

Source: Survey data in August 2012

4.4.1.7 Information searching skills

Information-searching skills were the ability to gather information for managers in the course of farm management. Table 4.7 shows that the farmers exhibited the highest score of ability in regards to continuing to improve management skills through study, with a mean of 3.80 (S.D=0.9), meaning a high level of ability.

In the other words, the farmers exhibited the lowest score of skill in regard to comprehending and following government policies on agriculture, with a mean of 2.92 (S.D=0.9), implying in a moderate level. The data point of this skill (S.D=0.9) was substantially spread out from the mean. One possible cause for this was that agricultural policies in Thailand were often modified with changed in the ruling party. Understanding and staying current with the latest changes in policy were extremely hard for farmers in these areas.

Among seven sub-skills, only the ability to continue studying for improving skills was ranked in high level, it implied that the farmers were willing to learn more information for improving their managerial ability and increasing their knowledge. In the meantime, the other six skills were essentially to consider in order to improve them to lead the high level.

Table 4.7 The average levels of information searching skill and sub-skills

Sub-skills	Friedman test	
	Mean (S.D)	
Information-searching skills	**3.23**	χ^2 = 28.997, p-value = 0.000
1 Continuing to improve management skills through study	3.80 (0.91)	
2 Ability to access, and use several information to developing farming	3.36 (0.91)	
3 Ability to collect information about new production technologies	3.24 (1.05)	
4 Ability to collect information on input prices and market	3.16 (1.18)	
5 Ability to find new and better ways of farming production	3.08 (1.08)	
6 Ability to collect information about government policies on agriculture	3.04 (0.98)	
7 Comprehension and practice government policies on agriculture	2.92 (0.95)	

Source: Survey data in August 2012

4.4.1.8 Accounting and financial management skills

Accounting and financial management skills refer to the ability of farm manager to efficiently manage financial and farm activities, facilitating financial success (i.e., a high net farm income) (Ford and Shonkwiler, 1994). Table 4.8 shows that the farmers exhibited the highest score of ability in regards to effectively obtaining financing and credit from various sources, with a mean score of 4.12 (S.D=0.5), implying at a high level.

On the other hand, farmers exhibited the lowest scores of ability in regard to documenting farm operations and recording and calculating capital and profits, with a mean of 2.16 (S.D=1.4), it means a low level of ability. One possible reason for this was that farmers perceive that farm operations and accounting were of low importance.

From these findings (Table 4.8), it is essential to consider how to improve the farmer's ability in regards to accounting and financial skills in this study area, especially the ability to keep records and how to use record data for developing farm management as well as controlling production cost.

Table 4.8 The average levels of accounting and financial skill and sub-skills

Sub-skills	Friedman test	
	Mean (S.D)	
Accounting and financial management skills	**2.98**	χ^2 = 81.053, p-value = 0.000
1 Ability to effectively get financial and credit from various sources	4.12 (0.53)	
2 Ability to control cost production by mix the cheapest input	3.32 (0.99)	
3 Ability to use on-farm data to determine costs of production and to help identify ways to lower costs	3.16 (0.94)	
4 Ability to record conducted production and consumed inputs	2.16 (1.49)	
5 Ability to record and calculate the amount of initial capital and profit	2.16 (1.49)	

Source: Survey data in August 2012

4.4.1.9 Marketing management skills

Marketing management skills play a pivotal role in the distribution of products to consumers and traders. Among the four sub-skills, the results in Table 4.9 presented that the farmers exhibited the highest score of ability in regards to analyzing demand, supply, and the current market, with a mean of 3.40 (S.D=1.0), suggesting in a high level.

By contrast, the farmers exhibited the lowest score of ability in regard to finding new markets and understanding how to enter into new markets, with a mean of 2.48 (S.D=1.2), meaning in a low level of ability. The data points of both skills were extremely far from the mean. The farmers in this area were indebted to a trader who collected their farm products in a monopolistic way; this situation was reflected their responses to the sub-scale questions. We surmised that the farmers feel that they did not have the strength to counter the trader and develop new markets.

Table 4.9 The average levels of marketing management skill and sub-skills

Sub-skills	Friedman test	
	Mean (S.D)	
Marketing management skills	**2.84**	χ^2 = 16.640, p-value = 0.001
1 Ability to analyze demand, supply and current market	3.40 (1.00)	
2 Ability to negotiate with buyers and set prices by themselves	2.84 (1.57)	
3 Ability to sell products directly to consumers	2.64 (1.75)	
4 Ability to find new markets and understand how to enter into new markets	2.48 (1.29)	

Source: Survey data in August 2012

4.4.2 Factors contributing to nine managerial skills

The results of regression analysis that found out the factors contribute to farm managerial ability are presented in Table 4.10. The results indicated that seven factors (X_1, X_2, X_3, X_5, X_6, X_7, and X_8) reached statistical significance in regards to farm managerial ability, except two skills (resource mobilization and communicative skills) did not. The *education variable (X_4)* did not a significant result.

Participation in group activities (X_1) was highly positive significant to the skills of accounting and financial management, marketing management, and planning and goal-setting. This result implies that this can be a key factor in order to support farmers in improving these skills. Participation in group activities provided greater opportunities for farmers to access information through exchanging experiences and knowledge. However, coming to a deeper understanding of the reasons behind these results requires further examination and analysis.

Household income (X_2) was significant and had a positive coefficient with information-searching skills, indicating that farmers with higher incomes may had more opportunities to access information through such as televisions, mobile phones, and the Internet.

Farmer's age (X_3) was significantly positive relationship with decision-making skills, implying that older people might have more confidence in making decisions than those younger people. On the other hand, *farming experiences (X_5)* had a negative correlation with decision-making skills, indicating that decision-making skills decrease with increasing farming experience. However, more evidence is necessary to confirm this result as in general age and farm experience had strongly correlation.

Rice-cultivated area (X_6) was strongly coefficient with planning and goal-setting skills. This indicates that farmers frequently used their planning skills when their paddy filed expand their paddy filed to the larger size. As a result, the farmers need to higher level of planning and goal setting skills.

Another, *farm working hours (X_7)* had a negative relationship with technical and risk-oriented skills, implying that farmers who worked longer working hours, had less technically skilled because they had few opportunities to access or learn about new technology.

Table 4.10 Factors contributing to nine skills of farm management

Variables	*t*-value								R^2
	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	
Resource-mobilized	1.658	0.558	-0.254	-1.013	0.882	1.603	-1.225	-0.463	0.433
Communication	1.769	-0.252	1.489	0.448	-0.700	0.785	-1.317	-1.766	0.798
Technical	0.903	1.064	1.126	-0.871	-1.212	0.640	-2.797 **	-3.782 **	0.678
Risk-oriented	1.844	0.976	1.657	-0.124	0.032	0.172	-2.665 **	-0.353	0.653
Decision-making	0.603	-0.023	2.880**	-0.979	-3.697 ***	1.527	-0.672	-3.263 **	0.642
Planning and goal setting	3.859 ***	0.192	-0.269	0.448	1.038	2.469**	-1.890	0.380	0.734
Information searching	1.664	2.589**	-0.917	-1.324	-0.145	1.070	-0.312	-2.975 ***	0.735
Marketing	3.862 ***	1.599	-0.455	-1.008	0.429	1.537	0.261	-1.437	0.707
Accounting and financial	4.330 ***	0.345	1.342	0.383	-1.130	1.301	-0.848	0.344	0.805

Source: Survey data in August 2012

Notes: **, *** significant at 5%, 1%

X_1=Participation in group activities; X_2=Household income; X_3= Farmer's age; X_4= Education; X_5=Farming experiences; X_6=Rice-cultivated area; X_7= Farm working hours; and X_8=Planting vegetables in rice fields

Finally, *planting vegetables in rice fields (X_8)* had a strong negative correlation with technical skills, and a slightly less negative correlation with decision-making skills and information-searching skills.

4.5 Summary

This study examines the level of farmers' managerial ability by using the managerial competency test, which is one approach of the noncognitive ability tests, and identify the specific factors associated with improving farmers' managerial ability in Khon Kaen province from the Northeastern Thailand. The results revealed that the farmers had the high level of ability in regards to risk-orientation, resource mobilization, decision-making, communication, technical, planning and goal setting. On the other hand, the farmers had the moderate levels of ability in regards to information-searching, accounting and financial management, and marketing management.

Furthermore, the findings pointed out that the factors contributing to improve farmers' managerial ability were participation in group activities, household income, farmer's age and rice cultivated area. With regard to these, participation in group activities was statistically significant and positively contributing to planning and determining skills, marketing skills, and accounting and financial management skills. In addition, household income was related to information searching skills, while farmer's age influenced positively decision-making skills of farmers. Finally, rice cultivated area was positively related to planning and goal setting skills.

Therefore, in order to improve farmers' management ability, farmers should be significantly advised to form and participate in farmers' group activities, especially the farmers with the moderate levels of ability in terms of marketing management, accounting and financial management, and searching information. As this technique will encourage farmers to active learning and intensive improving their skills.

Chapter 5
Farmers' Attitudes toward Farm Management and Farm Development

5.1 Introduction and specific objectives

In Thailand, rice is a major food crop that accounts for 47% of the total 23.8 million hectare (ha) for agricultural area. Rice generates national revenue, domestic employment, and cash income for farm owners, especially small-scale farmers (OAE, 2014). Accordingly, Thai government has undertaken various strategies to further increase rice production. These strategies include introducing modern techniques and technologies, training new farm practices, implementing various farm-related reform, and establishing local financial institutions.

To success of these strategies, both the responsibility of the government and agricultural officer and the cooperation from farmers are important. In addition, the strategies to increase agricultural production will be more successful if they correspond to farmers' values and attitudes (Palacios, 2005). This is due to farmers' attitudes being related to many farm decisions, especially gathering information and adopting new technology (Willock et al., 1999[a]).

Furthermore, as increasing rice production requires more knowledge and management skills. Therefore, it is necessary to study desirable changes in farmers' attitudes as first step in order to transfer knowledge, management skills and new farming practices to farmers. Gathering insight into farmers' attitudes will be useful information for the government to develop strategies and technologies on farm production management (Assefa et al., 2008) as well as increase production by improving farmers' attitudes toward farm management (Breuer et al., 2000).

In the case of Thailand, previous studies have stated that the majority of rice farms have considerable technical inefficiency (Athipanyakul et al., 2014; Chaovanapoonphol et al., 2005; Krasachat 2004; Rahman et al., 2009; Sriboonchitta and Wiboonpongse, 2005; Srisompun and Isvilanonda, 2012; Srisompun et al., 2013). From this result, various factors (e.g., age, education, farm experience, and farm size) contributing to increase technical efficiency have been considered. However, Thai rice farmers' attitudes on actual farm performance are not fully understood, even though they are considered as one of the key factors. To fill this gap, it is important to build an understanding of the attitudes toward farm management of rice farmers.

Accordingly, this chapter aims to estimate technical efficiency, including pure technical and scale efficiencies of rice farms using data envelopment analysis (DEA), and to study farmers' attitudes toward farm management and farm development by comparing efficient farms with inefficient farms. To perform this analysis, we hypothesize that farmers with efficient and inefficient farms have significantly different attitudes toward farm management and development.

5.2 Sample and data collection

The data were collected during August 2014 to August 2015 through face-to-face interviews 71 farmers using a structured questionnaire. The questionnaire consists of two parts. First, farmers were requested to provide information on farm size, yield of paddy rice, farm expenses, farm income, and the socio-economic characteristics of respondents, including their farm managerial ability. For the production data, we used the data based on crop cultivation from 2013 to 2014, by which rice is planted in August and harvested in December. For managerial ability, we applied the questions regarding four skills (i.e., planning, information, decision, and technical skills) from a case study of Utaranakorn and Yasunobu (2015). The questions were used to understand the perspectives of farmers using a 5-point Likert-scale (1 = very low to 5 = very high).

Second, to understand the rice farmers' attitudes better, farmers were questioned about their attitudes toward farm management, which consisted of eight dimensions: attention to farm performance, openness to ideas, business orientation, financial risk, success of the farm, satisfaction with farm results, emergent management, and stress behavior. Out of a total 26 questions, 19 were modified from the findings of Nuthall (2002, 2006, 2009[a]). The farmers answered using a 5-point Likert scale (0 = strongly disagree to 4 = strongly agree). Furthermore, informative questions to establish farmers' real attitudes with respect to farm development were provided, including as follows: "What points are you interested in for farm development? (multiple selection choices)"; "What is your solutions for solving farm problems?" and "How do you undertake farm planning for the long term?"

5.3 Analytical methods

The efficiency of a decision-making unit (e.g., firm or farm) can be estimated either using a parametric method (stochastic frontier approach), or a nonparametric method (data envelopment analysis or DEA). A DEA approach is developed to measure and compare the results of farm performance in terms of efficiency scores, where farm units represent the existence of multiple inputs and outputs related to different farm resources, farm practices, farm productions and environmental factors. The measurement of efficiency is that ratio of output (s) to input (s) (i.e. output/input). The description of the DEA model is followed by a discussion of some practical issue in estimating technique efficiency. The advantage of DEA is that it does not require the assumption of a functional form and the distributional assumption of the inefficiency term (Coelli, 1995).

When analyzing efficiency via DEA, two concepts of efficiency are used: (1)

technical efficiency, "measuring the ability of the farmer to produce maximum potential output, which still uses given a set of inputs and technology," and (2) allocative efficiency, "reflecting the ability of a firm to use the inputs in optimal proportions, given their respective prices" (Farrell, 1957).

The technical efficiency (TE) can either exhibit constant returns to scale (CRS) or variable returns to scale (VRS or pure technical efficiency). Furthermore, to estimate TE under CRS (or VRS), there are two considerations: input-oriented and output-oriented. The input-oriented (min cost) is used to examine "whether and to what extent it is possible to reduce its input (s) without reducing the output (s), whereas the output-oriented (max profit) determine "what is the maximum output producible from the same input bundle" (Ray, 2004).

The study used DEA approach under an output-oriented CCR (Charnes, Cooper, Rhodes) formulation with the assumption of both CRS to calculate technical efficiency and VRS to estimate pure technical efficiency, respectively.

For the DEA analysis, seven input variables were defined: *Land* (x_1) was the total hectare (ha) of rice-cultivated land, and *seed* (x_2) was the total seed used for rice production, referred in kilogram (kg) per ha. *Chemical fertilizer* (x_3) and *organic fertilizer* (x_4) were the total applied chemical and organic fertilizers for rice production (kg/ha). *Family labor* (x_5) and *hired labor* (x_6) were the total amount of family labor and total hired labor, respectively working on rice production (referred to person-days/ha). *Capital* (x_7) was the total of capital invested on farm (e.g. hired machines for land preparation and harvesting, fuel, etc.), referred in baht/ha. Output variable was the amount of *rice yield* (y_1) (kg/ha).

The output-oriented CCR DEA linear programming model is defined as follows (Coelli et al, 2005):

$$\max_{\phi, \lambda} \phi \quad (1)$$

$$\text{subject to} \quad -\phi y_i + Y\lambda \geq 0$$

$$x_i - X\lambda \geq 0$$

$$\lambda \geq 0$$

where, Y and X are the output and input matrices of the sample, respectively, y_i and x_i are the output and input vectors of the i^{th} farm, respectively, λ is a N x 1 vector of constants, and ϕ is the technical efficiency (TE) score of a farm, which is estimated by the DEA model. The value of ϕ is within the range $0 \leq \phi \leq 1$, where ϕ equal to 1 implies efficiency, and values less than 1 means inefficiency (Coelli et al., 2005).

Technical efficiency under the assumption of a variable returns to scale (VRS or pure technical efficiency) is obtained from a reformulation of (1) with a convexity constraint $N'\lambda = 1$, where N is an n x 1 vector of ones.

In this study, technical efficiency and pure technical efficiency scores were estimated through the data envelopment analysis online software (http://www.deaos.com). In terms of scale efficiency (SE), estimating is given by the ratio of technical efficiency to pure technical efficiency (TE_{CRS}/TE_{VRS}).

5.4 Results and Discussion

5.4.1 Descriptive statistics of the variables

Table 5.1 illustrates the summary statistics of the variables used in the DEA analysis. The results show that the paddy farmland ranged from 0.32 ha to 5.28 ha with a mean size of 2.12 ha. On average, the sample farmers planted 128.75 kilograms (kg) of seeds and applied 193.7 kg of chemical fertilizers and about 68.35 kg of organic fertilizers. The average family labor utilization for rice production was 14.64 person-days per ha, and 5.68 person-days of hired labor per ha. This result implies that the activities of rice production in this study area were mainly conducted by family labor. The mean capital per ha was 5,418.19 baht. The average yield of paddy rice in 2013/14 was 2,316 kg per ha, ranging from 136.71 kg/ha to 6,562.5 kg/ha. The result of the average yield in this study is quite close to the average rice production in 2013/14 in the Northeast region, with a mean of 2,275 kg/ha (OAE, 2014).

Table 5.1 Summary statistics of input and output variables for the sample farms

Variables		Mean(S.D)	Min	Max
Input	Land in hectare (ha) (x_1)	2.12(1.20)	0.32	5.28
	Seed in kg/ha (x_2)	128.75(60.40)	42.45	351.56
	Chemical fertilizer in kg/ha (x_3)	193.70(204.47)	0.00	1,517.85
	Organic fertilizer in kg/ha (x_4)	68.35(122.50)	0.00	625.00
	Family labor in person-day/ha (x_5)	14.64(14.80)	0.00	75.00
	Hired labor in person-day/ha (x_6)	5.68(12.18)	0.00	91.66
	Capital in baht/ha (x_7)	5,418.19(2,857.71)	178.57	13,046.87
Output	Yield of rice in kg/ha (y_1)	2,316(1,144.84)	136.71	6,562.50

Source: Survey data in August and December 2014
Note: 1 ha = 6.25 rai, Exchange rate: 1 US dollar = 30.71 Baht (approximately) during August 2014 (Bangkok Bank; http://www.bangkokbank.com)

5.4.2 Identifying efficient and inefficient farms based on technical efficiency scores

The estimations for the technical, pure technical and scale efficiency are presented in Table 5.2. The mean technical efficiency was 0.76 and varied from 0.23 to 1. These scores demonstrated that there remained substantial scope to increase production efficiency by increasing technical efficiency. The farmers should increase the effectiveness of their rice production techniques by 24% through increasing rice production (yield). In addition, it was found that more than 54% of the total 71 farmers achieved technical efficiency above 0.8, and 30% performed below 0.6 in terms of technical efficiency. The technical efficiency score was widely distributed from the minimum to maximum values. Furthermore, the mean score of pure technical efficiency was 0.82, which ranged from 0.25 to 1. Half of the sample farms were operated at the efficient level, but about 44% of the farms exhibited technical inefficiency. It is noteworthy that more than half of the farmers operated their farms below the average level of technical efficiency regarding the best farm practice.

The mean scale efficiency was 0.92, implying that the average size of a farm was not far from the optimal size. To adjust their farm operation to an optimal size, it should efficiently combine inputs and outputs both under constant returns to scale and variable returns to scale. In addition, Table 5.2 shows that more than half (54%) of the farmers had scale inefficiency, meaning the majority of the farmers were not operating their farms at the optimal scale.

Regarding the objective of understanding farmers' attitudes, we divided farmers into two types: efficient and inefficient farms. "Efficient farms" are defined as "farms that have a technical efficiency score equal to 1," whereas "inefficient farms" are defined as "farms that have a technical efficiency score less than 1." Based on the results of technical efficiency shown in Table 5.2, 45% of the sample farms were efficient farms (n=32), whereas the remaining (55%) were inefficient farms (n=39).

Table 5.2 Distribution of technical (TE), pure technical (PTE) and scale efficiency (SE) scores of rice farms

Frequency		TE	PTE	SE
Mean(S.D)		0.76(0.27)	0.82(0.25)	0.92(0.14)
Minimum		0.23	0.25	0.30
Efficient (%)	1.00	45.1	56.4	46.5
Inefficient (%)	0.90−0.99	5.6	4.2	29.6
	0.80−0.89	2.8	2.8	9.9
	0.70−0.79	9.9	9.9	7.0
	0.60−0.69	5.6	5.6	2.8
	<0.60	31.0	21.1	4.2
	Total	54.9	43.6	53.5

Source: Survey data in August and December 2014

5.4.3 Demographic profile of rice farmers between efficient and inefficient farms

The sample farmers differed in terms of farm size and technical skills (Table 5.3). They were similar along several other characteristics, including age, education, farm income, planning skills, information searching skills, and decision-making skills. The mean ages were 52 and 54 years for farmers with efficient and inefficient farms, respectively. This result implies that farmer's age had no influence on the farmer's ability to produce maximum output with a given number of inputs. The two types of farmers with efficient and inefficient farms had education of 7 years, indicating a primary school.

There was a significant difference between the two types of farmers regarding total farm size. The average farm size of efficient farms (3.21 ha) was relatively low compared to that of inefficient farms (5.03 ha). This finding indicates that efficient farms typically had less land with greater crop production than inefficient farms. This might be because farm activities (e.g., land preparation, transplanting, weeding, and harvesting) required more time on large farms than on small farms, unless farmers adopted efficient machinery. In fact, farmers in rural areas generally had less effective machinery and/or new technology. This might impede larger (inefficient) farms from conducting farm activities, using efficient inputs, and adopting techniques correctly. Consequently, this might cause farmers to produce less rice (yield), thereby resulting in inefficient farms.

Furthermore, farmers with inefficient farms differed significantly from those with efficient farms in terms of the level of technical skills. While the average ability of farmers with inefficient farms was 2.85, for those with efficient farms, it was 3.20. This result implies that farmers with efficient farms had a higher level of technical skills than those with inefficient farms, which might cause the different technical efficiency scores between the efficient and inefficient farms in the study area.

Overall, farmers with efficient and inefficient farms had quite similar demographic profiles, implying similar endogenous factors.

Table 5.3 Farms and farmers characteristics of efficient and inefficient farms

Variables	Efficient (n=32)	Inefficient (n=39)	*t*-test statistic
Age (year)	51.94	53.71	-0.656
Education (year)	6.88	6.18	0.781
Farm size (ha)	3.21	5.03	-2.948***
Farm income (baht)	179 686	201 750	-0.635
Planning skills [a]	3.48(0.83)	3.35(0.86)	0.602
Information searching skills [a]	3.20(0.86)	3.08(0.93)	0.577
Decision-making skills [a]	3.65(0.76)	3.55(0.71)	0.554
Technical skills [a]	3.20(0.79)	2.85(0.85)	1.788*

Source: Survey data in August and December 2014

Note: [a] Scale was 1 = very low, 2 = low, 3 = moderate, 4 = high, 5 = very high,
*, *** significant at 10%, 1%

5.4.4 Farmers' attitudes toward farm management between efficient and inefficient farms

To gather more information to identify potential ways to increase the production efficiency of rice farms, descriptive statistics were used to understand farmers' attitudes toward farm management between efficient and inefficient farms. For this study, all eight domains of attitudes toward farm management were relevant to the farmers: attention to farming, openness to ideas, business orientation, financial risk, success in farming, satisfaction, emergent management, and stress behavior. Comparisons between efficient and inefficient farms were made regarding the farmers' attitudes toward farm management using a t-test to prove our hypothesis (see Table 5.4 to Table 5.8).

5.4.4.1 Attention to farming

Farmers with both efficient and inefficient farms gave the highest ratings of "strongly agree" to six attitudes of attention to farming (Table 5.4). There was no significant difference between efficient and inefficient farms on all six styles, indicating that both types of farmers paid more attention to operating their farms. These findings show that these farmers carefully considered their decisions, chose solutions based on their experience more than feeling, were concerned about the active management of their farms, had the ability to undertake all farm activities, searched for information before making changes, and quickly found out problems. This means that the farmers engaged the same set of farm management practices.

Table 5.4 Mean scores of attitudes of attention to farming

Farm management styles	Efficient Mean(S.D)	Inefficient Mean(S.D)	*t*-test statistic
Attention to farming			
1. Careful thinking about decisions before acting	3.86(0.36)	3.76(0.44)	0.815
2. Choosing solutions from experiences rather than hunches	3.57(0.51)	3.56(0.51)	0.076
3. Being very active to operate and manage on farm	3.19(0.75)	3.00(1.00)	0.719
4. Having ability to be able to land preparation, planting, fertilizing, weeding, water and protecting the crops then harvesting, storing and marketing the crop to get the best price with little waste	3.00(0.71)	2.88(1.05)	0.444
5. For most things, searching overviews of many people for information before making changes to farm operation	2.95(0.74)	2.80(0.87)	0.635
6. Being able to obtain relevant information on any problem quickly	2.81(0.93)	2.68(0.63)	0.562

Source: Survey data in August 2015

Note: Scale was 0 = strongly disagree, 1 = disagree, 2 = undecided, 3 = agree, 4 = strongly agree

5.4.4.2 Openness to ideas

Regarding the farmers' openness to ideas, there was no significantly different attitude between farmers with efficient and inefficient farms (Table 5.5). Both groups of farmers had significantly high scores for usually discussing everything with their family members or relatives and easily gathering technical information from others. The remaining four aspects also show no significant differences between efficient and inefficient farms, implying that these farmers were open to alternative ways to develop their farm management. Specifically, their attitudes favored easily contacting other people or organizations and enjoyably discussing technical information. These points imply that extension officers would receive highly cooperation from farmers when transferring information about modern technologies and new farm practices.

Table 5.5 Mean scores of attitudes regarding the openness to ideas

Farm management styles	Efficient Mean(S.D)	Inefficient Mean(S.D)	*t*-test statistic
Openness to ideas			
1. Usually discussing everything with family members/relatives	3.81(0.40)	3.64(0.91)	0.792
2. Easily contact with other people to gather technical information	3.14(0.57)	2.96(0.61)	1.040
3. Normally enjoy being involved in professional organization	2.57(1.12)	2.68(1.14)	-0.323
4. You not only speak your mind and ask questions at professional meeting, but also enjoy the involvement	2.52(0.98)	2.44(0.96)	0.292
5. Using specialist advisers to help analyze the important physical and financial aspects of your farm.	2.52(0.98)	2.24(0.93)	1.008
6. Finding out to talking to others about practice/ professional ideas stimulates and excites you as well as increasing your enthusiasm for new idea	2.48(1.17)	2.44(0.96)	0.115

Source: Survey data in August 2015

Note: Scale was 0 = strongly disagree, 1 = disagree, 2 = undecided, 3 = agree, 4 = strongly agree

5.4.4.3 Business orientation and financial risk

In Table 5.6, the two types of farmers agreed with having farm planning for the long term. More than half of the efficient farms (57%) kept records for both farm activities and finances, whereas 60% of the inefficient farms did not. In addition, during the field surveys some of the farmers with efficient farm recorded their farm operations and finances in notebooks, while the majority simply retained the information in their minds or inserted notes in calendars. These results indicate that keeping records on farm practice was not yet an effective tool for the study area, despite the extension officers' attempts to promote record keeping by providing record books and training programs.

Table 5.6 Mean scores of attitudes about business orientation and financial risk

Farm management styles	Efficient Mean(S.D)	Inefficient Mean(S.D)	*t*-test statistic
Business orientation			
1. Having long term planning on farm production	3.14(0.96)	3.20(1.08)	-0.188
2. Keeping records on farm activities is very important	2.33(1.62)	1.68(1.75)	1.304
3. Preparing financial and physical records at regular	2.10(1.51)	1.56(1.76)	1.095
Financial risk			
1. Tending to write and calculate monetary before deciding	2.71(0.96)	2.76(0.78)	-0.179

Source: Survey data in August 2015

Note: Scale was 0 = strongly disagree, 1 = disagree, 2 = undecided, 3 = agree, 4 = strongly agree

5.4.4.4 Success in farming and satisfaction

The results in Table 5.7 show that farmers with efficient and inefficient farms attempted to achieve successful farming through different ways of preparing and selling their products as well as finding new approaches. However, they seem to have low opinion about sharing their successes and failures with other people. A possible reason is that the farmers were not confident about whether their successes and/or failures were beneficial to other people.

With regard to satisfaction, the two groups of farmers agreed that they enjoyed the results of farm planning, and were happy to use the materials that they had on hand.

Table 5.7 Mean scores of attitudes regarding success and satisfaction with farming

Farm management styles	Efficient Mean(S.D)	Inefficient Mean(S.D)	*t*-test statistic
Success in farming			
1. Assessing the different ways of preparing and selling the farm products	2.57(1.25)	2.20(1.08)	1.082
2. Finding out the investigating new approaches to your work exhilarating and challenging	2.29(0.85)	2.08(1.04)	0.728
3. Sharing your successes and failures with your relatives and/or neighbor	1.48(1.33)	1.20(0.97)	1.049
Satisfaction about farming			
1. Being much happier if everything is planned well ahead of time	3.24(0.70)	3.20(0.76)	0.175
2. Being happy to make do with what materials you have to hand	3.10(0.83)	3.04(1.02)	0.199

Source: Survey data in August 2015

Note: Scale was 0 = strongly disagree, 1 = disagree, 2 = undecided, 3 = agree, 4 = strongly agree

This implies that the farmers were highly satisfied with their farm operations, including their successes and failures.

5.4.4.5 Emergent management and stress behavior

Even though the majority of the farmers' attitudes toward farm management styles were the same, a different attitude between farmers with efficient and inefficient farms occurred for emergent management (Table 5.8). The farmers with efficient farms tended to overcome any mistakes or accidents involving family or employees more than did those with inefficient farms. One of the main conclusions is that farmers with efficient farms paid more attention to comprehending how to use machinery or facilities. Simultaneously, they budget for insurance, especially accident insurance. This implies that the farmers with efficient farms were more concerned about the safety of farm operations than those that had inefficient farms. However, this did not mean that farmers with inefficient farms did not consider safety. These farmers also tried to overcome mistakes and accidents by carefully using the machinery, but they had less opportunity for insurance due to limited funds.

Finally, regarding stress behavior, the two types of farmers had become better at management under pressure. The farmers rested when they felt tired even though their jobs had not yet been completed. In addition, the farmers could sleep well at night without worrying about the results of decision-making. These results imply that the farmers in this study area enjoyed farm activities.

Table 5.8 Mean scores of attitudes with respect to emergent management and stress behavior

Farm management styles	Efficient Mean(S.D)	Inefficient Mean(S.D)	*t*-test statistic
Emergent management			
1. Tending to overcome mistakes and accidents that occur with family members and/or hired labor	2.43(1.03)	1.88(1.27)	1.858*
Stress behavior			
1. Tending to worry about what others think of your methods	1.00(1.26)	0.88(1.27)	0.320
2. When there are too many jobs for the time available you sometimes become quite anxious	0.95(1.24)	0.80(1.15)	0.430
3. You sometimes don't sleep at night because of worrying about decision made	0.76(1.14)	0.88(1.20)	-0.340
4. You normally don't rest until the job is fully completed	0.48(0.81)	0.76(1.20)	-0.920

Source: Survey data in August 2015
Note: Scale was 0 = strongly disagree, 1 = disagree, 2 = undecided, 3 = agree, 4 = strongly agree; *Significant at 10%

5.4.5 Farmers' attitudes toward farm development of efficient and inefficient farms

Different farmers' characteristics and areas have varied aspects of farm production that require improvement. In this sector, farmers' attitudes were categorized in three aspects. First, most farmers with efficient farms (80%) and inefficient farms (70%) considered that improving the quality of farm production and reducing production costs were the most significant points (Table 5.9). A possible reason for this result is that these farmers had high production costs due to the increasing prices of inputs (e.g., fertilizers, fuel, and chemicals). At the same time, the farmers had inadequate capital to invest in their farm. Consequently, the majority of farmers were indebted to moneylenders because they had difficulty accessing credit, even though the Thai government had established the Bank for Agriculture and Agricultural Cooperatives (Note 1). For the other aspects, 52% of the farmers of efficient farms and 36% of the farmers of inefficient farms highlighted the need for higher selling prices because they usually received low prices from collectors. These findings indicate that the most significant strategic directions and development programs for the farmers in this study area were improving the quality of farm production and reducing production costs.

Second, the majority of the farmers of efficient farms (90%) and inefficient farms (80%) affirmed that they could generally find farm problems, but they could not solve the problems as quickly. One of the reasons for unresolved problems over time is that most farmers did not confident about solving problems by themselves, and preferred to consult with local farmers or agricultural officers who possessed the knowledge and ability to comprehend solutions clearly. Unfortunately, local farmers and/or officers were not always available. These results indicate that agricultural officers should consider training farmers to help them in solving problems by themselves. Moreover, setting time for monthly group discussions and listing agricultural problems in villages would be essential for farmers and officers to devise potential solutions to problems.

Finally, across the entire sample, the farmers of more than 80% of both efficient and inefficient farms conducted long-term planning to create farming plans easily. Although the majority of farmers practiced long-term planning, approximately 14% of efficient farms, and 8% of inefficient farms had plans that were not particularly clear. In addition, 4% of farmers of inefficient farms did not practice any farm planning. These results indicate that planning is an important area for further work. Specifically farmers who had no clear farm plan require advice on how to create clear and effective farm planning in both the short and long term. This is because planning is the most important function of farm management to help farmers select the right production and technology in the right way at the right time (Kay et al., 2016).

Table 5.9 Farmer's attitudes toward farm development between efficient and inefficient farms

Perceptions	Efficient (%)	Inefficient (%)
Interesting points of farm development		
Saving labor	0.0	4.0
Improving quality of farm production	81.0	72.0
Improving technology/technique	14.3	16.0
Looking for high selling price	52.4	36.0
Reducing production cost	81.0	68.0
Saving cost	28.6	28.0
Solving farm problems		
If I find problems, I solve the problem as soon as possible	9.5	16.0
I could find problems, but I can't solve as soon	90.5	80.0
I could not find problems and solve it by myself	0.0	4.0
Creating farm planning for long-term		
I easily create and have long-term planning	85.7	88.0
I set long-term planning, but it is not really clear	14.3	8.0
I do not have any long-term planning	0.0	4.0

Source: Survey data in August 2015

5.5 Summary

This chapter employed nonparametric technique, as called data envelopment analysis (DEA) to estimate technical and pure technical efficiencies. Then, the results of technical efficiency score was used to identify farmers into two groups, which are farmers with efficient farms and farmers with inefficient farms in order to clarify their attitudes toward farm management and development.

The findings of this study revealed that the average scores of technical, pure technical, and scale efficiency were 0.76, 0.82, and 0.92, respectively. This implies that farmers had some room for improving in technical and scale efficiencies. In addition, more than half of farms were operated at neither the efficient level nor the optimal scale. Furthermore, based on the technical efficiency score, 45% of farms were efficient and 55% were inefficient. Meanwhile, there were no significantly different attitudes toward farm management by farmers of efficient or inefficient farms in terms of attention to farming, openness to ideas, business orientation, and financial risk. Moreover, both types of farmers strongly agreed with aspects related to enjoyment and were happy being involved in farm activities. However, it is noteworthy that the farmers with efficient farms paid more attention to overcoming mistakes and accidents that occurred with family members and/or hired labor than the farmers with inefficient farms did. Finally, both types of farmers considered that improving the quality of farm production and reducing production costs were the most significant aspects of farm development.

In order to achieve full potential impacts of the development strategies and/or policies, clarifying farmers' attitudes and receiving cooperation from farmers are required. This study shows that the farmers are willing to open their mind to receiving more ideas and paying more attention to farm practices in order to increase their farm production efficiently. Thus, the extension officer should greatly consider farmers' attitudes when addressing development strategies and/or training programs in order to obtain strongly cooperation from farmers. Furthermore, the agricultural officer should devote to concern about how to improve quality of production and how to reduce production costs during creating a new development policy and/or project.

Although the specific structured set of farmers' attitudes (e.g., farm resource management, input application, and marketing management) were not included in this study, the results were able to show certain responses according to the attitude scales, thereby reaching the actual farm management practices of farmers in this study area. To overcome that lack of a specific structured set of farmers' attitudes, future research should consider other aspects of attitudes, which would generate more valuable information for the development of appropriate programs to improve the production management and production efficiency of rice farms.

Note 1

The Bank for Agriculture and Agricultural Cooperatives has been established in the rural areas of Thailand for delivery low-cost credit to Thai farmers. The main objectives are to provide financial assistance (credits) directly to farmers, agriculture cooperatives, and farmers' associations at below-market interest rates for agriculture and agriculturally-related activities (Bank for Agriculture and Agricultural Cooperatives, 2016).

Chapter 6
Searching and Sharing Agricultural Information within Social Networks

6.1 Introduction and specific objectives

To be insight on how farmers' group activities encourage farmers to improve their management ability (as presented in Chapter 4) as well as how farmers gather agricultural information within their social network for developing their farm management capability, this chapter chose an organic vegetable group as a case study. This is because organic vegetable production is an important economic activity for the farmers in Thailand, including in the Northeast farmers. As it brings in an attractive income in a short time. The Thai government has encouraged farmers to grow organic vegetables as well as to form groups in order to increase their marketing power. However, owing to various problems and constraints, organic vegetable farmers have trouble producing enough to meet the high market demand.

Previous studies have stated that organic vegetable growers have recently faced low vegetable production, lack of modern knowledge, and low-level management ability, such as in pest and marketing management (Mondal et al., 2014; Timprasert et al., 2014; Mukiama et al., 2014). Moreover, the vegetable growers suffer from such difficulties as seasonal shortages of water, aging farmers, problems accessing capital, being too poor to enter the market, and low market values for their products (Jitsanguan, 2001; Andreas et al., 2012).

Given the aims of promoting vegetable growers, improving managerial ability is an appropriate solution. "Managerial ability" refers to a farmer's degree of capability in managing farm inputs (i.e., labor, land, and capital) and farm resources, including farm operations, to reach farm goals (Allahyari et al., 2011).

However, improving managerial ability is not easy because it is commonly determined by a farmer's characteristics, such as age, educational level, farm experience, training programs, and source of labor (Nuthall, 2009[b]; Lawrence, 2011; Yarmohamadi et al., 2014). In addition, previous research has shown that social networks promote improvement in managerial ability (Hoang et al., 2006; Isaac et al., 2007). For example, social networks play a pivotal role in farmers' decision-making about adopting new technologies (Matuschke and Qaim, 2009; Tatlonghari et al., 2012). Furthermore, Seeniang and Thaipakdee (2013) pointed out that it is necessary to consider how farmers/stakeholders share problems and exchange knowledge as well as experiences.

Therefore, the objective of this chapter is to investigate the farmers' processes of searching and sharing agricultural information within their social networks with regard to improving their abilities.

6.2 Sample and data collection

To understand how farmers access the agricultural information in order to improve their managerial ability and farm production, the data collection was conducted in two sub-districts namely Wang Hin and Ban Han, where an organic vegetable group is located. The farmers' group had produced and sold surplus organic vegetables in both local and urban markets. The group consists of a group leader, group managers, and group members. Purposive random sampling was used to select the sample farmers.

In all, 37 farmers who belong to the organic group were listed as possible respondents. The list of potential respondents was obtained during a consultation meeting with the local people, including the group leader and the development officers. We interviewed 34 farmers (92%) by using a structured questionnaire in September 2013. The questions focused on farmers' managerial abilities and the number of farmers' networks. Managerial abilities were assessed via a 5-Likert scale. For obtaining information on farmers' social networks, farmers could be asked "to name a maximum of three people with whom they often discussed agricultural decisions" (Matuschke and Qaim, 2009) or "to name an unlimited number of other people within their social network." For this study, we chose the second method, asking farmers to provide the number of people they frequently consulted and with whom they discussed agricultural issues. We believed this question would elicit more information about the exchanges between the farmers and other network members. After reviewing the literature and considering our options, we included the following two questions: (1) "To whom do you usually turn for agricultural information?" and (2) "What agricultural issues do you discuss within your networks?" in order to access the topics of information discussed within connected networks. The data derived from answers to the first question were used to analyze the social network.

6.3 Analytical methods

Descriptive statistics (i.e., frequency and percentage) were used for the level of the farmer's managerial ability and frequency of discussions within the networks. We employed an interval scale to interpret the mean score of managerial ability. Five rankings were set as follows: very low = 1.00–1.79, low = 1.80–2.59, moderate = 2.60–3.39, high = 3.40–4.19, and very high = 4.20–5.00. For the social network analysis, UCINET 6 for Windows Version 6.487 (Borgatti et al., 2002), was applied for drawing farmers' networks.

6.4 Results and Discussion

6.4.1 Socioeconomic characteristics of farmers

The age of farmers ranged from 29 to 67 years (mean=48 years) and the average farm size was 3.6 ha, with an average area of 1.7 ha for rice cultivation. The number of vegetable varieties planted averaged seven. The household income was 233,133 baht per year, with approximately 75% of the household income of group members being generated from farming. Farm income was derived from selling rice, sugarcane, cassavas, fruit and vegetables, and livestock products.

6.4.2 Managerial ability of farmers

Figure 6.1 shows that about 59% of the respondents had a high level of managerial ability, implying that the major farmers had good skills in farm management. As farmers' participation in the organic vegetable group increases, they had more chances to increase their skills through training programs, learning from farming centers, and exchanging experience and knowledge among group members, including connectors.

In addition, not only were marketing skills improved but also information, communication, and technical skills developed in order to increase farmers' marketing power. As a result, about 75% of the farmers in the study area had very high and high levels of marketing skills. Moreover, the results revealed that most of the farmers had a high level of technical skills (79.4%), communicative skills (64.7%) and information skills (61.8%).

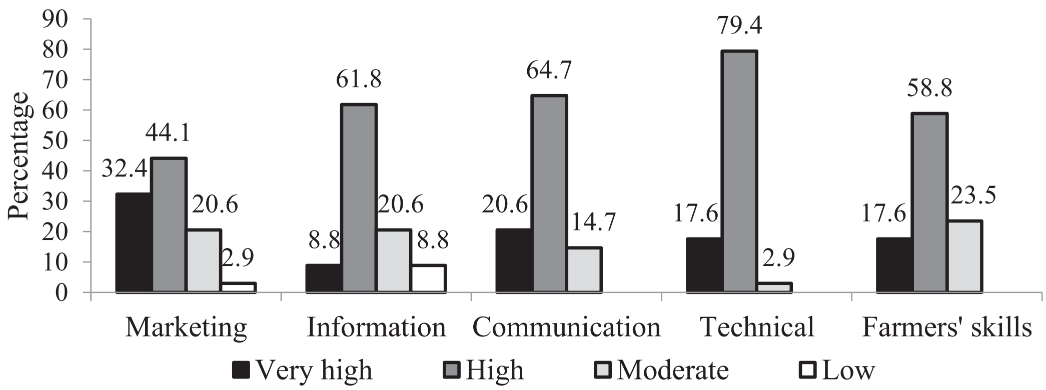


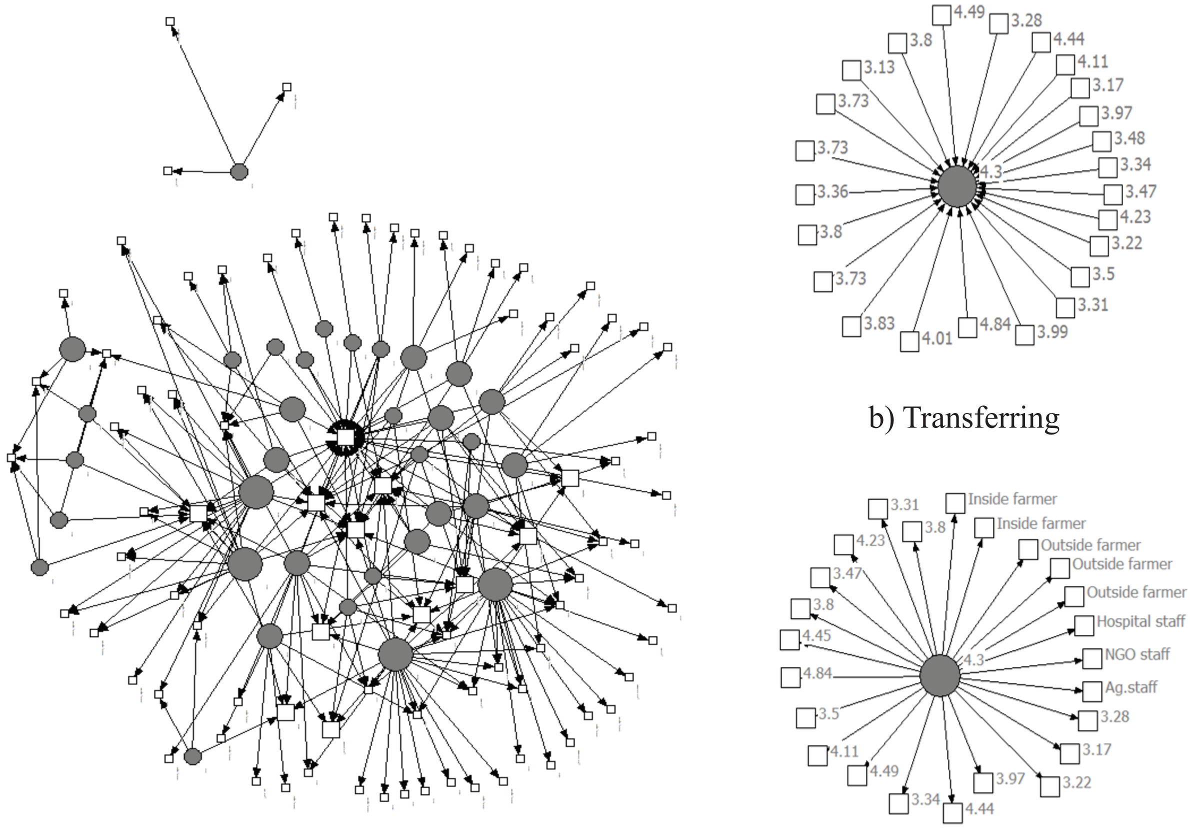
Figure 6.1 Managerial ability of farmers toward farm management

6.4.3 The structure of farmers' social networks

In Figure 6.2, the numbers referred to the number of connectors that the sample farmers usually met to access and share agricultural information. Figure 6.2a shows that farmers with high managerial ability had larger networks than those who had low ability. They often connected with other actors, and other actors customarily consult with them. In particular, these farmers hold high positions within the farmers' group, such as head or vice-head and marketing manager. They also often met with other group members to discuss agricultural conditions and problems, as well as with other farmers from nearby villages and the staffs of farmers' organizations outside the villages (Totterdell et al., 2008). The farmers holding high positions usually acquired more experience and technical skills than those who did not. The high-ability farmers had also frequently sought out new techniques and information to develop their farms better, whereas the other farmers waited to see the benefits of new techniques/technologies before deciding to adopt them.

6.4.4 The network structure of farmers with high managerial ability

The farmers with high ability scores had attracted many networks within their group (Figure 6.2b). One reason for this is that these farmers were more confident in their investment in farm products and in learning from collective activities. In addition, high-ability farmers were willing to encourage other farmers to develop their farms and improve their managerial abilities, so they often discussed and transferred their knowledge to other farmers and/or neighbors. Moreover, if farmers with low managerial ability experienced any problems during the growing season, they preferred to consult with farmers possessing high knowledge and ability. The farmers believed these networks to be sufficient to solve any problems. This result confirmed the finding of Isaac et al. (2007), who stated that farmers who lack the knowledge to manage agricultural resources often rely on information obtained from their local social networks.



b) Transferring

a) The structure of networks c) Accessing

Figure 6.2 The structure of transferring and receiving agricultural information

Note: ● The circles represent the farmers who participated in this study.

□ The squares represent other connected networks that the respondents consulted (ex. □3.99 means average abilities of group member)

In the case of high-ability farmers, Figure 6.2c also shows that these farmers not only transferred information to encourage other connectors but also had more opportunities to expand their networks for accessing and learning about information, new knowledge and modern technology both inside and outside their communities. The networks of farmers with high ability consisted of agricultural, university, hospital, and NGO staffs; teachers; farmers inside and outside the village; and the farmers' group members. These chances promoted farmers to improve their managerial ability at the high ability level.

6.4.5 Information sharing topics within connected networks

The topic most discussed by farmers within their social networks (Table 6.1) was the safe- planting of vegetables (124 cases), followed by marketing management (38 cases), and producing organic fertilizer, compost, and manure (31 cases), including farm management (28 cases). In their social networks, farmers usually consulted with other community farmers daily, and they usually contacted government officers. Farmers both inside and outside the villages were the primary contacts for all farmers in the study area because they relied on their local social networks to access information and felt

Table 6.1 Information sources for farmers' agricultural information and number of times discussed in the group

Unit: Numbers of cases

Discussion topics	Information sources (n=34)									Total
	GM	IF	OF	G	T	AG	H	U	NG	
1.Safely planting vegetables	69	10	24	3	1	15	-	-	2	124
2.Marketing management	23	4	5	-	1	2	-	1	2	38
3.Producing organic fertilizers, compost and manure	13	3	5	2	1	7	-	-	-	31
4.Farm management	13	5	3	3	1	3	-	-	-	28
5.Controlling pests and diseases	3	-	2	-	-	2	1	-	-	8
6.Rice productivity	-	-	1	-	-	7	-	-	-	8
7.Planting economic crops (e.g., sugar cane and cassava)	1	2	-	-	-	-	-	-		3
8.Safety of using chemical herbicides and pesticides	-	-	-	-	-	-	2	-	-	2
9.Others	5	-	13	-	-	4	2	-	-	24
Total	127	24	53	8	4	40	5	1	4	266

Source: Survey data in September 2013

Note: GM= Group member; IF= Other farmers inside village; OF= Farmers outside village; G= Local government office; T= Teacher; AG= Agricultural staff; H= Hospital staff; U= University staff; NG= NGO staff most comfortable discussing agricultural matters with other local farmers. This finding suggests that local residents have a better understanding of current farming conditions than do people from outside (Isaac et al., 2007).

6.5 Summary

The aim of this chapter was to clarify how farmers access and transfer agricultural information within their connected networks regarding to improve their managerial ability. Results show that most farmers in the study area had a high ability level in farm management, and this managerial ability helped them in forming wide networks. Particularly, high-ability farmers were becoming the centers of consultants among farmers in the local community in terms of transferring information and technology. In addition, inside their networks and/or group activities, the farmers had opportunities to learn and improve their ability through information sharing and exchanging experiences as well as problems.

Overall, in order to improve farmers' managerial ability, emphasizing the idea of farmer-to-farmer learning and information exchanging within networks should be considered and disseminated to other groups and/or communities. This is because it makes easy for farmers to access information and effortless for extension officer to transfer new knowledge. In addition, extension services that provides opportunities for farmers to participate in training programs, visit farm demonstration centers, and receive support for inputs and new technologies could help farmers to improve their managerial abilities and farm practices.

Though almost all of the farmers had a high ability level, some farmers had a low level of marketing and information searching skills. This issue lays the groundwork for future studies to address such questions as "Why do some farmers have low ability?" and "What are their problems and constraints?" Such information will benefit policymaking and implementation in agencies that aim to improve programs and strategies for further development policies.

Chapter 7

Farmers' Decision-Making in Agricultural Problems

7.1 Introduction and specific objectives

Studying farmers' decision-making is the best way to gather valuable information to formulate constructive policy and make effective decision to solve problems and avoid risks (Willock et al., 1999[a]; Ali and Kumar, 2011; Hansson and Ferguson, 2011). In addition, an improved understanding of farmers' decision-making processes will assist those working in the farm advisory sector and farmers to achieve their goals more effectively (Long, 2013).

Farming problems are not generally under the control of farmers and the types and severity of problems that farmers face differ from place to place. Accordingly, different farmers make different decisions to solve problems, even when their farms are located in the same area and have a similar environment. As a result, different decisions lead to different farm outcomes. Therefore, clearly explaining the difference in farm outcomes is crucial to clarify farmers' decision-making processes, especially decision making related to farming problems (Wilson et al., 2001).

Even though there has been much research studying the agricultural problems affecting farmers, specific information on the relative importance of farmers' decision-making for problems is rarely gathered. In spite of the evidence available (e.g., Poungchompu et al., 2013; Wirongrong et al., 2015), questions remain that need to be answered: "how do farmers identify agricultural problems, what are the impacts of problems that have affected farmers and how do individual farmers make decision to deal with problems?" Therefore, to gain insight into the practical aspects of farmers' decision-making for agricultural problems, it is crucial to discuss all the related issues.

This chapter aims to describe farmers' making decision for agricultural problems in Northeastern Thailand and illustrate the decision events through case studies in order to give empirical evidence on how to make good enough decision.

7.2 Sample and data collection

This study was carried out in Nong Song Hong district of Khon Kaen province, Northeastern Thailand, in August 2016. The farm-level data were collected by face-to-face interviews based on a structured questionnaire. The questions focused on farmers' decision-making in agricultural problems and the decision events. With regard to farmers' decisions, the concept of decision-making defined by Öhlmér et al. (1998) was employed, which includes problem defining, identifying solution, analyzing and choosing, and implementation. To obtain the information on farmers' defining agricultural problems, five-Likert scales were used, including 1=not serious, 2=minor serious, 3=moderate serious, 4=major serious and 5=disaster.

In this study, in order to verify and describe various aspects of the decision-making of farmers, 57 farmers were selected using a purposive sampling technique. A data envelopment analysis (DEA) approach was also used to select several case studies, in order to explain the events experienced by the individual farmers making the decisions. The results of this DEA approach showed that five farms had technical, allocative and economic efficiency scores equal to 1. Based on this result, these five were taken as benchmarks for case studies of the individual farms.

7.3 Analytical methods

Descriptive statistics such as mean, standard deviation and percentage were used to describe the farmers' detection of problems, implementation and experiences of decision-making events within the case studies of individual farmers.

7.4 Results and Discussion

7.4.1 General characteristics of the sample farmers

Table 7.1 summarizes the general characteristics of the sample farmers. The average age of the farmers was 56 years old, and age ranged from 32 to 77 years old. The educational level of the farmers was approximately primary school level (6.7 years); about 21% of the sample farmers had completed high school, and 4% had graduated from university. The average length of farming experience of these farmers was 34 years, of which the majority centered on rice farming practices. On average, household contained 4 people, and generally involved two parents and two children. The average total farm size was equal to 27.7 rai, with an average of 13.7 rai for rice paddies, 7.5 rai for cassava, 7.8 rai for sugarcane and 0.4 rai for growing vegetables. To cultivate these crops, the farmers relied on rain-water. These farmers decided to grow vegetables when they had enough water (e.g., by installing underground water supplies) all year round.

Table 7.1 General characteristics of the sampled farmers (n=57)

Characteristics	Mean (±S.D)
Farmers' and farms' characteristics	
Farmers' age (years)	55.7 (±11.4)
Education (year)	6.7 (±3.8)
Farming experience (years)	33.8 (±14.7)
Family member (persons)	4.2 (±1.5)
Total farm size (rai)	27.7 (±17.7)
Rice	13.7 (±7.6)
Cassava	7.5 (±7.2)
Sugarcane	7.8 (±8.1)
Vegetables	0.4 (±0.6)
Farm's goal of farmers (multiple)	
Primary for home consumption and sale surplus (e.g., rice, vegetables)	86.0%
Primary for market and some for home consumption (e.g., vegetables, cassava, sugarcane)	33.3%
Exclusively for home consumption	7.0%

Source: Survey data in August 2016

The primary goal of farm performance for 86% of farmers was primarily food such as rice and vegetables for home consumption and a surplus to sell on the market for a cash income (Table 7.1). Some farmers (33%) affirmed that their primary goal was for market such as sugarcane, cassava and vegetables with some for home consumption (e.g., vegetables). A few farmers had two goals: major production both for home consumption (e.g., rice) and for the market (e.g., cassava, sugarcane and vegetables). These farmers mainly worked on their own farm all year round and relied on farm income for their livelihood.

7.4.2 Sources of technical information and roles in farmers' decision-making

The results in Table 7.2 show that the farmers mainly searched for technical information from personal sources, "other farmers" who stand at the center of agricultural consultants in the village. After other farmers, the farmers looked for technical information from farmers' meeting (84%) and agricultural staff (43%). In addition, more than half of farmers (57%) accessed technical information by watching television programs about 'smart farmers', 'farmers with production efficiency' and 'visiting a learning center of integrated farming'. A few farmers preferred to search for information on the internet using a computer or smart phone. They said "this information source provided up-to-date information for them".

Table 7.2 also shows the role of personal information sources for the decision-making process. Family members were preferred in the 'detecting problems' phase. This is possibly because family members are familiar with the farm environment and can help the decision maker observe and identify problems. With regard to seeking solutions and new farm practices, farmers checked their choice of solutions with other farmers, people in their network who they trust. This implies that other farmers were perceived in terms of their effects on farmers' decision-making when solving problems. In addition, farmer's personal network can be extremely important for information gathering and finding new farm practices.

Agricultural staff were rated in third place in the 'seeking solution and new farm practices' phases. This is because there are not enough agricultural staff to help the farmers. For example, one staff member looked after farmers from four sub-districts, which was difficult to manage and meant they could not help farmers when problems occurred.

Table 7.2 Information sources and the role of information sources in making decision

Information sources	% of farmers (n=57)
Technical information sources (multiple)	
Other farmers	100.0
Farmers meeting	84.2
Agricultural staff	43.9
Television	57.9
Radio	15.8
Others (e.g., technical advisor, agricultural books, learning center, the internet)	38.8
Sources of information for farmers making decision	
Identifying problem	
Family members	59.6
Other farmers	35.1
Agricultural staff	5.3
Seeking for solutions	
Other farmers	64.9
Family members	21.1
Agricultural staff	17.5
Commercial agents	5.3
Seeking for new farm practices	
Other farmers	70.2
Family members	19.3
Agricultural staff	15.8

Source: Survey data in August 2016

7.4.3 Identifying agricultural problems

To obtain information on what kinds of problems affected farmers in recent years and how it affected, studying the process of farmers' defining in agricultural problems was carried out. The results show that the farmers acknowledged more than one kind of problem, and they found problems that effect more than one level (Table 7.3). Of the eight problems, the most serious that most farmers (70%) encountered was severe drought (mean=3.40). In addition, more than half of farmers said this problem occurred every year. In fact, they suffered drought from 2013 to 2015, with the most serious in year 2014. During the three years of drought, half of production, particularly paddy rice, was lost and some farmers did not have enough rice for home consumption.

Most farmers (80%) said low prices for products sold (mean=3.23) were a serious problem that happened every year. The farmers determined the impacts of this problem were decreasing farm income, less profitability and low opportunity to return debt by the deadline.

Other problems appeared every year, such as speed of weed growth (e.g., herbs and grasses), of which 92% of farmers affirmed it. Weeds forced farmers to work hard to remove them and some farmers spent money on labor for weeding, which increased production costs. Another problem was the outbreak of pests and diseases. More than half of farmers (66%) faced this problem every year, such as "rice blast disease" in paddy fields. This is the most significant disease affecting rice cultivation and the leaf and stem parts of the plant, resulting in a lower yield. However, half of farmers said these two problems had a minor serious affect.

Furthermore, most farmers identified problems of changing policy, lack of family labor, limited farm size and less capital on hand as not serious impacts. But 28% of farmers said that less family labor was a major serious problem as it lead to an increase in the cost of production from paying wages to hired labor.

Table 7.3 Distributions of farmers' perception on problem detections (n=57)

Problems	Occurring every year	Levels of problems' impacts				
		Mean [a)] (S.D)	Major serious	Moderate serious	Minor serious	Not serious
1. Severe drought	54%	3.40 (1.08)	70%	3%	12%	10%
2. Low prices of selling products	80%	3.23 (1.07)	59%	14%	15%	10%
3. Speeding of weeds	92%	2.60 (0.88)	21%	22%	50%	5%
4. Distribution of pests and diseases	66%	2.46 (0.95)	17%	24%	43%	14%
5. Changing policy	7%	1.60 (0.88)	5%	10%	22%	61%
6. Lack of family labor	50%	2.25 (1.33)	28%	17%	5%	49%
7. Limited farm size	3%	1.11 (0.56)	3%	0	0	96%
8. Less capital	5%	1.23 (0.71)	3%	5%	2%	89%

Source: Survey data in August 2016

Note: Five-Likert scales, 1=not serious, 2=minor serious, 3=moderate serious, 4=major serious, 5=disaster

Of these farmers, those that managed their farm effectively seemed to see agricultural problems as not serious or minor impact (see more evidence in Table 7.4). The explanation on why these farmers saw these problems this way, especially severe drought and low selling prices is discussed in the next section and looked at some case studies.

7.4.4 Problems definition and implementations of farmers

In the search for solutions (problem definition), farmers chose the appropriate solutions based on the levels of the problem's effects. However, most farmers were rarely interested in evaluating the effect of a solution. In this study, to review the processes of farmers' defining and implementing problems, all 57 farmers were asked to give information on how they deal with eight problems.

The result in Figure 7.1a shows that 49% of farmers, who faced severe drought, decided to wait for rain fall. Other solutions were to "do nothing" as farmers believed that acting gave no benefit when there was no water at all. These results indicate that a half of farmers did not take action to overcome the problem; and among these farmers (49%), most of them were likely to receive inefficient farm outcomes.

On the other hand, 30% of farmers took actions to deal with this problem. Some farmers (8%) who defined problem as a major serious, believed renovating a farm pond and making it deeper could solve severe drought problem long term if rain fell more regularly. In addition, among these 30% of farmers, 5% had installed underground water system since they believed they could produce several crops and have higher profits without worrying about water sources in the future.

During our observation, farmers who could manage water effectively (e.g., by installing underground water) did not face any serious problems that affected their farm production and living standards. This is because they could deal with the problem in the long term, whereas the other farmers implemented year-to-year solutions.

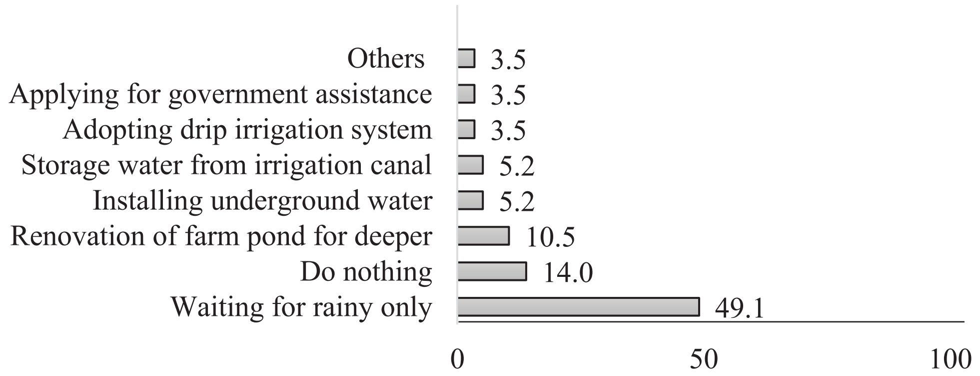


Figure 7.1a Farmers' actions to deal with drought problem

A problem of low selling prices, 47% of farmers, particularly who acknowledged this problem as a major serious, did nothing (Figure 7.1b). This is because they believed they did not have enough power to negotiate with collectors and/ or middlemen. Among these 47% farmers, some farmers stated that "whatever price I can get, I am happy with" as they relied on that income, and saying "some is better than nothing". Interestingly, 21% of farmers decided to adopt crop rotation to cope with the low selling prices problem. They believed that this solution provide diversity of farm production and helped them avoid price risk and receive a farm income all year round.

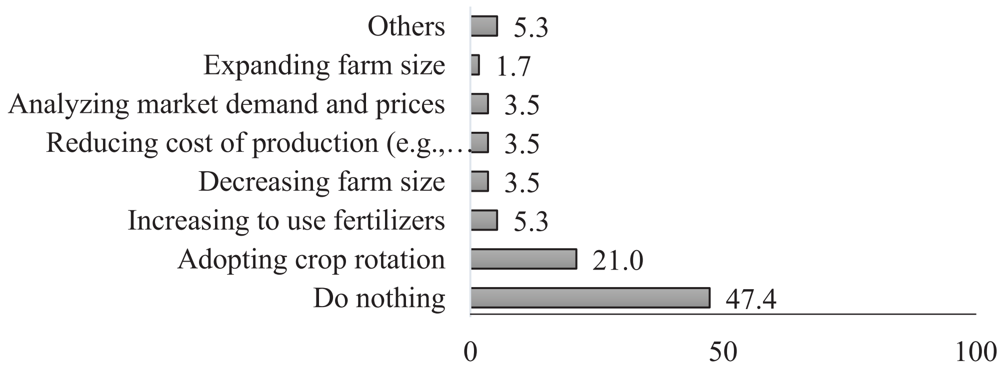


Figure 7.1b Farmers' actions to deal with a problem of low prices of selling products

Speed of weed growth was mostly seen as a minor serious problem. The most popular solution considered by farmers was hand weeding by farm manager and/or hired labor, followed by using a chemical herbicide (Figure 7.1c). In terms of outbreak of peats and diseases, farmers chose to wait for rain to clean pests and diseases, followed by using chemical pesticides, and removing and burning it (Figure 7.1d).

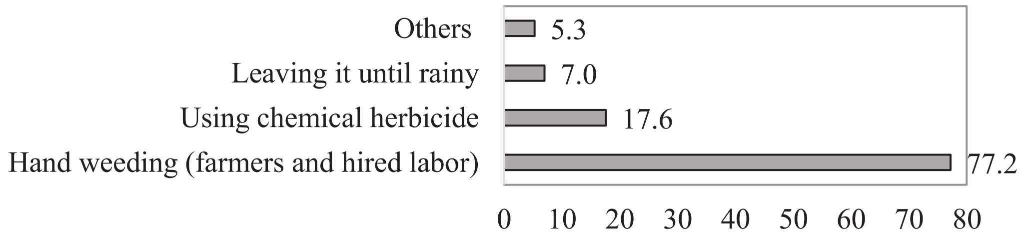


Figure 7.1c Farmers' actions to deal with a problem of speeding of weeds

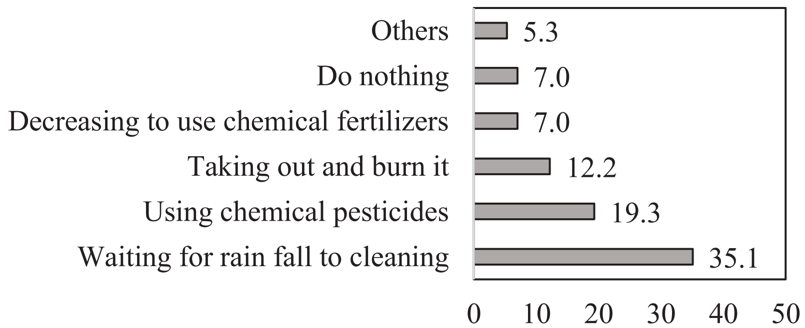


Figure 7.1d Farmers' actions to deal with a problem of distribution of pests and diseases

Furthermore, the problem of less family labor was often solved by hired labor, but this solution led to increasing production costs. Finally, the farmers perceived problems in changing policies, limited farm size, and less capital with regard to a minor serious impact. Their decision in solving these problems were rarely made, unless farmers “did nothing”. As these problems were not serious problems defined by farmers and farmers rarely solved it, therefore, there is difficult to draw the figures.

Overall, most farmers who defined the problems as a major serious rarely took solutions to react the problems, and most of them likely received ineffective farm outcomes. In fact, those farmers who accounted the problems as a minor serious, usually decided to take several actions in order to deal with the problems, resulting in achieving efficient farm outcomes.

7.4.5 Decision-making events for individual farmers through case studies

To provide clearly evidence to confirm that effective farmers have good enough decisions to deal with the problems, explaining the decision-making events of individual farmers was carried out in this study. To do this, a DEA model was used to identify benchmarks of the best farm practices among 57 farmers by calculating production efficiency. "Benchmark farms" are defined here as farms that have technical, allocative and economic efficiency scores equal to 1. This also implies that the farmers have the effective ability to produce maximum potential outputs and to use inputs at optimal proportions at a minimum cost. One reason behind the selection of these benchmarks was to find potential ways to improve decision-making processes for other farmers. Based on the results of the DEA approach, five case studies of individual farms were undertaken in this study.

Our observations of decision-making events for these five farmers are discussed below. Table 7.4 shows general characteristics of farmers as well as how farmers making decision in agricultural problems with regard to the processes of problem defining and searching for solutions.

Table 7.4 General characteristics and decision-making in problems of five case studies

Characteristics	Case studies				
	Farmer A	Farmer B	Farmer C	Farmer D	Farmer E
Farmers' characteristics					
Age (years)	71	66	64	66	35
Education (years)	4	4	4	18	16
Farm experience (years)	57	32	32	22	5
Household side (people)	4	7	6	6	4
Total farm size (rai)	80	24	42	21	48
Problem definitions and solutions					
Severe drought	(not serious) -Dig pond -Installing underground water system	(minor) -Dig pond -Using irrigation canal	(minor) -Installing underground water system -Adopting drip irrigation system	(moderate) -Renovating pond	(minor) -Applying for assistance -Adopting drip irrigation system
Low prices of selling products	(minor) -Analyzing market demand & prices -Joining marketing group	(moderate) -Applying integrated farming -Joining marketing group	(moderate) -Same as Farmer B	(moderate) -Same as Farmer B	(moderate) -Same as Farmer B
Speeding of weeds	(moderate) -Weeding by hand -Feed cow	(minor) -Weeding by hand	(moderate) -Same as Farmer B	(moderate) -Same as Farmer B	(moderate) -Weeding by hand -Cutting machine
Distribution of pests and diseases	(minor) -Decreasing to use chemical fertilizers	(moderate) -Take it out & burn it	(moderate) -Same as Farmer B	(moderate) -Same as Farmer B	(moderate) -Take it out -Crop rotation
Changing policy	(not serious)	(minor)	(moderate) -Growing short period crop -Vegetables	(moderate) -Same as Farmer C	(moderate) -Same as Farmer C
Lack of family labor	(not serious)	(not serious)	(not serious)	(major) -Exchanged labor	(not serious)
Limited farm size	(not serious)	(not serious)	(not serious)	(not serious)	(not serious)
Less capital	(not serious)	(not serious)	(not serious)	(not serious)	(moderate)

Source: Survey data in August 2016

7.4.5.1 Case study: Farmer A

Farmer A is known as the learning center of integrated farming; he said that "if you are a diligent person, you can do anything". This farmer is 71 years old and completed primary school grade four. He is married and has four children. There were four members for his family, and his youngest daughter helps him work on farm activities.

According to Farmer A (see more detail in Appendix), he started working as a full time farmers on his farmland when he was 26 years old. Actually, he became a farmer when he was 11 years old because his father passed away and he needed to help his mother work on the family farm. After he got married in 1971, he decided to work on his own farmland as he need to take care of his new family. This farmer had never worked off-farm as he liked this job and did not want to
work in the surrounding village.

Originally, Farmer A planted rice, cassava and sugarcane as his main crops. He intended to work hard to make money to further the education of his children. He said that he planted and harvested cassava and sugarcane without hired labor, and sold it to make an income. Initially, he used animal power for land preparation. In 1986, to save time and labor, he decided to buy a tiller for land preparation. As his tiller was the first machine in the village, he was hired by many of other farmers.

In 1996, Farmer A was faced with a most serious drought, which meant that he did not have enough rice for home consumption. Following this, he searched for several ways to deal with this problem by consulting with other farmers, an agricultural officer and informal school staff. In 2001, he decided to dig a farm pond, with support from the Agricultural Land Reform Office (ALRO) and Japan International Cooperation Agency (JICA). He also installed underground water system to provide water for agricultural activities all year round. When he had enough water, he produced not only rice, cassava and sugarcane but also vegetables, fruit and feed for cows. The most important aims of changing his farm system were to increase the farm's income and to improve his family' living standards.

Farmer A often spent time searching for new information by participating in a group selling organic vegetables and by visiting the learning center. He also observed and analyzed the market demand and products' prices before making decision to growing vegetables. To increase production, this farmer decided to expand the size of his farm by buying more land. Farmer A divided his time between livestock rearing and crop production, including vegetables and fruit. In the morning, he spent time cutting grass to feed 24 cows. After lunch, he tended to the cows, and planted and harvested vegetables and fruit. Since Farmer A was generally needed to take care of the cows, his daughter and wife usually transported their farm produce to sell in local markets both in their own and in near-by villages. Currently, Farmer A's household relies on farm income for their living.

7.4.5.2 Case study: Farmer B

Farmer B is 66 years old and, completed her education through primary school grade four. She is married and has three children. Only one of her children provides principal agricultural labor; the other two work in Bangkok. Farmer B's vision is "by doing today, you can get money today".

With regard to decision-making in agriculture, this farmer started to help her parents work on the farm while studying at primary school (as can be seen from Appendix). Two year after she was married, she started working as a full time farmer on her own farmland (17 rai). With her husband, she initially planted rice for home consumption, and sugarcane and cassava for a cash income. To increase farm production, she expanded her farm through buying about 5 rai of farmland and using a tiller for land preparation instead of animal power. This farmer planted the same crops every year.

Before turning to integrated farming, Farmer B attempted to increase her income by going to Bangkok with her children to work off-farm in 2007. After two years, however, she decided the work was not suitable, and felt uncomfortable, so she went back to working on the farm. During the period following this, her farming goals changed from "primarily for home consumption, with any surplus sold on the market for a cash income" to "primarily for market, with some production for home consumption". To seek the best way to develop the farm and achieve maximum income, Farmer B often consulted with other farmers and the agricultural officer. In 2010, she was given support from ALRO and JICA to dig a farm pond in order to supplying enough water for her farm activities. In same year, she became interested in integrated farming when she participated in an organic vegetable selling group. Initially, she planted vegetables at the learning center. After she gained an understanding and a deeper knowledge of the farming system, she moved back to work on her farmland and converted her farm to the integrated system.

Presently, with her husband, she grows crops around the pond such as coriander, celery, spring onion and eggplant. She has also grown pumpkin, sweet corn and luffa in the rice field after harvesting. Her primary purpose in doing this was to increase the farm's income and improve the fertility of the soil. About four days per week, Farmer B sell vegetables and other farm products directly to consumers in local markets both in her own and in other villages through organic group. This marketing group's activities support her to higher prices of selling products as she could set prices by herself. Furthermore, the integrated farming system has helped her to pay all her debts, and has allowed her to save money so that her family can rely on the farm's income for their living.

7.4.5.3 Case study: Farmer C

Farmer C is 64 years old and completed his education through primary school grade four. He is married and has three children. The household has four members, all full-time farmers. Farmer C and his wife started working full-time with a total of 25 rai of farmland (rice=15 rai and cassava=10 rai). In the beginning, he used animal power for land preparation then to reduce time for land preparation he bought a tiller in 1992. In 1995, he expanded his farmland to increase production by buying 17 rai. To store rain water for agriculture, he decided to dig a pond in 2001 (undertaken by ALRO and JICA). Farmer C planted rice, cassava and sugarcane as his main crops until 2012 (see Appendix).

Since this farmer was attempting to rely on the income from his farm, he made an effort to seek out information and new technology by consulting other farmers and agricultural officers and by watching television. This farmer also visited the learning center and observed good farm management. After evaluating the work involved in several development options, he decided to participate in the organic vegetable selling group in 2013. He said, "If we are diligent, we can bring in more income."

Farmer C believed that water was important for his farm activities, and therefore installed an underground water system in 2014. When he had enough water, he stopped growing cassava and applied integrated farming techniques on his farm. He started growing various kinds of vegetables (such as lime, chili, eggplant, '*Dok Kajhon*', and tomato) and fruit (such as banana, papaya, and mango) for both consumption and sale. To reduce the costs of fertilizer, he produced liquid compost for growing vegetables and on the rice field.

With regard to farm production, he and his wife harvested vegetables in the early morning (at approximately 5 a.m.), and cleaned and packaged then. Around 8 a.m., Farmer C took products by motorcycle to sell to villagers both inside and outside his own villages. His products were sold every two days.

To increase his income, Farmer C decided to grow mushroom following a visit to a learning center dealing with mushroom farming. He used some of his own capital and received support from the local government office to invest in building mushroom houses and buying mushroom bags. He currently sells various forms of farm produce such as lime, chili, eggplant, '*Dok Kajhon*', banana, papaya and mushrooms. As a result, he can rely on the income of his farm for a living, pay his debts and have some money left over for investment in the farm in the future.

7.4.5.4 Case study: Farmer D

This farmer is a retired teacher. He is 66 years old and, completed his education through to a Master's degree in 2003. He is married and has two children. Two of his children were able to complete their Master's degree. Presently, one works in Bangkok and the other as local government officer in a near-by village. Therefore, there are two workers at home and Farmer D is particularly responsible for agricultural work.

He started work as a part-time farmer in 1977, growing about 12 rai of paddy rice (can be found in Appendix). In 1992, he decided to dig a pond for storing water for agriculture and applied for the money from a teachers' saving group. After he retired as a teacher in 2009, he started working as a full-time farmer. His main purpose in farming is for health reason and for exercise as well as to generate additional income. In 2010, he bought a further 9 rai of new farmland, and used this land for integrated farming.

After observing and evaluating the benefits of joining a farmers' group, Farmer D decided in 2012 to participate in an organic vegetable selling group aimed at increasing knowledge and negotiated power with buyer. As this group gave him a chance to sell his products directly to consumers. He became more interested in this, and joined several organized group activities. From these activities, he gained greater knowledge, inspiration and confidence to work as a manager on his farm. Furthermore, in order to search for more information and knowledge about integrated farming and farm practices, he read newspapers, agricultural books and journal for several hours per day. He also often consulted with farmers at the learning center.

Since vegetables need constant tending, this farmer recently decided to grow bamboo, fruit trees (such as coconut, mango, jack fruit, lemons, and custard apple) and utility trees on his integrated plots. He has sold his farm produce by asking several group members to sell it for him.

7.4.5.5 Case study: Farmer E

This farmer is 35 year old and completed her education through a Bachelor's degree. She is married and lives with her parents. Presently, both Farmer E and her husband are full-time farmers. Before becoming a farmer, she worked in Bangkok as a dental assistant, with salary about 15,000-28,000 baht per month. She sent money to her parents both for their living and for developing the farm such as reshaping farmland, buying fertilizers and growing limes.

Farmer E is the youngest daughter and needs to take care of her parents. She also became interested in integrated farming after watching TV programs while working in Bangkok, and aims to use this farming system effectively. In 2012, she decided to return to her hometown and started working as a full-time farmers (see also in Appendix). She utilized 48 rai of integrated farming land, which included 25 rai for rice, 10 rai for cassava, 4 rai for sugarcane, 5 rai for vegetables, 3 rai for farm ponds and a house on 1 rai. In the same year, she decided to participate in the organic vegetable selling group to increase her knowledge of farm practices and enter the market. In 2013, she started to grow vegetables (such as spinach, kale, Chinese cabbage and broccoli) in a greenhouse, with support from ALRO and JICA.

To provide enough water for growing vegetables, she applied for assistance from the Land Development Department (LDD) to dig a pond in 2014. Due to irregular rainfall, she did not have enough water, and was faced with serious problems from drought in 2015. Following this, she decided to stop growing vegetables in the greenhouse to deal with this problem. She started growing sweet-corn, chili and lime, installing a drip irrigation system in order to use less water. Furthermore, to overcome the severe drought problems, she is planning to renovate an underground water source within the next two years.

Currently, Farmer E receives income from the farm, particularly from selling sweet-corn in daily markets and selling vegetables twice per week.

Overall, the effective farmers decided to take several alternatives to coping with the problems that affected their farm outcomes and their livelihood. In addition, before farmers acting new alternatives, they usually searched for information from various sources (e.g., other farmers, agricultural staff, reading books, watching TV and observation at the farming learning center) as well as analyzed the impacts of new alternatives. Accordingly, it affirmed why these five farmers made decision efficiently and achieved farm outcomes effectively.

7.5 Summary

The objectives of this chapter were to describe farmers' decision-making for agricultural problems and explain the decision events of individual farmers through case studies. The findings show that other farmers were the preferred source of technical information and had the most important role in personal information for decision-making processes, especially when seeking solutions and new farm practices. In terms of detecting problems, more than half of the farmers saw severe drought as having a major and serious effect on their farm production, followed by low sale prices for products.

With regard to solving problems, in case of severe drought and low prices, most farmers chose solution such as waiting for rainfall and doing nothing. The majority of farmers chose solutions on a year-to-year basis, and rarely considered solutions for the long term. This suggests that they are likely to face the same problem again.

Through these case studies, it can be seen that the farmers who managed farms effectively, and who assessed problems as being minor or not serious, researched several solutions for overcoming these problems. Before acting, these farmers evaluated the estimated impact of alternative solutions and chose the most effective of these. Since these farmers relied on income from their farms, they were often interested in searching for information from several sources to develop their farm practices. They developed their farms step-by-step and year-to-year through adopting new farm practices and modern technologies.

Overall, the findings show that the processes of problem detection and implementation were not sufficient to overcome these problems in the long term. To assist farmers in making effective decisions, the processes of searching for solutions and analyzing the effect of those solutions before acting should be taken into consideration when formulating development strategies.

Chapter 8
Evaluation of Technical, Allocative and Economic Efficiencies

8.1 Introduction and specific objectives

With regards to government policy, farmers in Thailand recently have tended to produce multiple crops, including cash crops, as the growing of multiple crops provides substantial income. Accordingly, farmers in Northeastern Thailand have been producing not only paddy rice but also sugarcane and cassava in order to increase their household income. However, the average yield per rai for these crops and the household income of these farmers in this region is ranked among the lowest compared with other areas (OAE, 2014). Against this backdrop, the most effective way to address this is to improve overall production efficiency through improving farmers' abilities to use inputs in optimal proportions and to produce maximum outputs (Li et al., 2010).

Estimating a farm's economic efficiency scores has remained an important step in order to improve production efficiency. This can also be a benefit in the establishment of new agricultural policies and the development of new technology through showing farmers how production efficiency can be increased by either reducing inputs or increasing outputs. Economic efficiency is generally the combined result of technical efficiency and allocative efficiency (Farrell, 1957).

Although the analysis of economic efficiency has been very useful for policymakers, there has not yet fully understood it. As previous research has mostly concentrated on analyzing the technical efficiency of mono-cropping of rice (Krasachat, 2004; Rahman, 2009; Athipanyakul et al., 2014). These studies rely on rice to play a key role in the national economy and an important life crop for Thai people that generates income, employment, and food security.

To meet the challenge of greater production and maximum income, this chapter therefore, aims to measure technical, allocative and economic efficiency among multiple cropping systems (outputs) and use the data gathered to identify the possible sources of technical and allocative efficiencies that ultimately impact economic efficiency.

8.2 Sample and data collection

To calculate technical, allocative, and economic efficiencies, we randomly selected 71 farmers to interview during August through December of 2014, using a structured questionnaire. Specifically, all the farmers had at least one pond on their farm with the owner-operator focused mainly on farm activities and the sampling of farmers quite similar in terms of soil fertility. Out of the 71, 56 farmers live in the Wang Hin sub-district of the Nong Song Hong district, the others live in the Ban Han sub-district of the Non Sila district, located in Khon Kaen Province. These two sub-districts are involved in the "Project for Revitalization of the Deteriorated Environment in the Land Reform Areas through Integrated Agricultural Development (Stage 1)." The main cropping systems included rice (planted in August and harvested in December), cassava (planted in August to October and harvest beginning in July the following year), and sugarcane (planted in October and harvest beginning in December the following year). These crops served not only as food but also as a major source of income and employment for the people in this area. The data used (e.g., land, labor, fertilizer, yield of rice, sugarcane, cassava, and prices) were obtained from one-year cycle of crop cultivation (August 1, 2013 - July 31, 2014). In examining the yield of three crops, we included all production both for home consumption and for sale.

To determine the factors that influence technical and allocative efficiencies, the technical and allocative efficiency scores are considered a dependent variable. Based on socio-economic characteristics, we define six independent variables as follows. *Farm* *experience (d_1)* is the total number of years that a farmer acts as the farm manager. *Farm managerial ability (d_2)* is an average calculated from nine skill measures: planning, decision-making, accounting, marketing, information searching, communicating, risk orientation, resource mobilization, and technical skills. To measure these nine skills, we modified the questionnaire used by the case study of Utaranakorn and Yasunobu (2015). We established 9 skills (comprised of 44 sub-skills) and provide a five-point Likert-scale (1=very low to 5=very high). Because managerial ability is strongly correlated with the nine skills, we use it as a proxy variable of nine skills. *Family labor (d_3)* is the number of family members who are fully engaged in farm activities. *Farm size (d_4)* is a dummy variable, which small farms is defined as a farms of less than 20 rai (1 = small-scale farmland (<20 rai), 0=otherwise). *Irrigation system (d_5)* is also a dummy variable: 1 = access to more than one irrigation stem, 0 = otherwise. Finally, *farm machine (d_6)* is a dummy variable: 1 = tractor, 0 = otherwise.

8.3 Analytical methods

In this study, estimating efficiency measured how family farms perform under the assumption of constant returns to scale (CRS). This implies that if the input is multiplied by a given factor, its output is also multiplied by the same factor (Charnes et al., 1978). Technical efficiency measures the ability of the farmer to produce maximum potential outputs under a given quantity of inputs. Allocative efficiency reflects the ability of the farm to use inputs in optimal proportions at the minimum cost (Farrell, 1957). Economic efficiency means choosing an optimal level and structure of inputs and outputs with respective market prices in order to maximize revenue (Coelli et al., 2005).

To estimate technical efficiency, two methods are widely applied: Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). This study applied the DEA model as it can analyze multiple inputs and outputs in different units

(Coelli et al., 2005). The output-oriented CCR (Charnes, Cooper, Rhodes) DEA model under the assumption of CRS was employed to calculate technical efficiency. It is defined as follows (Coelli et al., 2005):

$$\max_{\phi,\lambda} \ \phi \qquad (5)$$

$$\text{subject to} \quad -\phi y_i + Y\lambda \geq 0$$

$$x_i - X\lambda \geq 0$$

$$\lambda \geq 0$$

where Y and X are the output and input matrices of the sample; y_i and x_i are the output and input vectors of the i^{th} farm, respectively; λ is a matrix of parameters; and ϕ variable is the technical efficiency rate that varies between 0 and 1. This variable indicates the need for increasing output to achieve efficiency; where 1 indicates efficiency, and ϕ less than 1 indicates inefficiency.

An estimate of economic efficiency under the assumption of CRS can be obtained from the following model:

$$\max_{\lambda,y_i^*} p\, y_i^* \qquad (6)$$

$$\text{subject to} \quad -y_i^* + Y\lambda \geq 0$$

$$x_i - X\lambda \geq 0$$

$$\lambda \geq 0$$

where y_i^* is the revenue-maximum vector of outputs (Coelli et al., 2005); and p is the average of input prices of the farmers, except for the wage rate, which is based on a national standard. Economic efficiency is given by the ratio of $p\, y_i / p\, y_i^*$ that is the radial measure of the observed revenue to maximum revenue.

With the assumption of CRS, technical and economic efficiencies can be estimated through the Data Envelopment Analysis Online Software (https://www.deaos.com), where Allocative efficiency is calculated by the ratio of economic efficiency to technical efficiency.

8.4 Results and Discussion

8.4.1 Descriptive statistics of all variables

Table 8.1 presents the summary statistics of all the variables used in the DEA model. In the DEA model, the input variables were: *Land* (x_1), with the average total cultivated farm land equal to 25.7 rai; *Labor* (x_2), which referred to man work days on the farm. To calculate this variable, total working hours of both family labor and hired labor was combined and then divided by eight. The mean of labor on the farm was 121 man days. *Fertilizers* (x_3), farmer applied chemical fertilizers had a mean of 1,233 kg per farm. *Other costs* (x_4), included all expenditures on other inputs (e.g., seed, fuel) and all farm management costs (e.g., land preparation, transplanting, harvesting, and other items) measured in baht. The average of this variable was 36,546 baht per farm. The output variables were the yield of the three crops in tons; the average yield of *paddy rice* (y_1), s*ugarcane* (y_2), and c*assava* (y_3) were 4.7, 44.1 and 18.4 tons per farm, respectively.

Table 8.1 Summary statistic of variables using in DEA model

Variables	Units	Definitions	Mean (S.D)
Inputs			
Land (x_1)	rai	Total cultivated land area per farm (1 rai = 0.16 ha)	25.7 (16.4)
Labor (x_2)	man day	Amount of total family and hired labor for working on farm	121.4 (100.3)
Fertilizers (x_3)	kg	Quantity of using chemical fertilizers per farm	1,223 (1,246)
Other costs (x_4)	baht	Including all expenditures on seeds and fuel, and all costs for land preparation, transplanting, harvesting, transportation and food for laborers, measured in baht per farm (1USD=30.77 baht)	36,546 (29,925)
Outputs			
Paddy rice (y_1)	tons	Quantity of rice yield per farm	4.7 (3.3)
Sugarcane (y_2)	tons	Quantity of sugarcane products per farm	44.1 (82.6)
Cassava (y_3)	tons	Quantity of cassava products per farm	18.4 (24.5)

Source: Survey data from August and December 2014

In terms of the Tobit regression model (Table 8.2), scores for TE and AE were set as dependent variables. There were six independent variables. The average level of *farm experience (d_1)* was 30 years and the estimated mean of the *managerial abilities (d_2)* of the sampled farmers was 3.3. The average of the abilities was calculated from the perspective scale (five-point Likert scale) of nine skills, consisting of risk orientation, resource mobilization, decision-making, communication, technical, planning and goal-setting, information-searching, accounting and financial, and marketing (see more from Utarnakorn and Yasunobu, 2015). The average of *family labor (d_3)* working on the farm was 57.7 man days, mainly including the head of the household and wife. To identify the small farm impact on TE and AE, the sample small farms were defined as farms of less than 20 rai (World Bank, 2003, as cited in Nagayets, 2005). Approximately 41 percent of the farms were small farm. Moreover, about 17 percent of the farmers had moved to more than one *irrigation system (d_5)* (e.g., pond with groundwater and/or irrigation canal); only 11 percent of the farmers had an own *farm machine (d_6)* such as a tractor.

Table 8.2 Summary statistic of variables using in Tobit regression model

Variables	Units	Definitions	Mean (S.D)
Dependent variables			
Technical efficiency		Scores of technical efficiency (TE)	0.79 (0.2)
Allocative efficiency		Scores of allocative efficiency (AE)	0.76 (0.1)
Independent variables			
Farm experience (d_1)	years	Years of farming experience	30 (14.3)
Managerial abilities (d_2)		Scores of farmer's managerial abilities that were calculated from the scaling perspective of nine skills (1-5)	3.3 (0.7)
Family labor (d_3)	man day	Amount of family labor available for mainly working on farm	57.7 (61.6)
Farm size (d_4)		Farm size (dummy: 1=small-scale farmland (< 20 rai), 0=otherwise)	40.8%
Irrigation system (d_5)		Irrigation system (dummy: 1=access to more than one irrigation system, 0=otherwise)	16.9%
Farm machine (d_6)		Farming machine (dummy: 1=tractor, 0=otherwise)	11.3%

Source: Survey data from August and December 2014

8.4.2 Technical, Allocative and Economic Efficiencies

To verify the robustness of efficiency scores, New Slack Model (NSM) which is proposed by Agawal et al. (2011) was applied. The result shown that the efficiency scores of the farmers were robust as there were not sensitive to efficient farms. In Table 8.3, the average technical efficiency for all the farm sampled was 0.79, indicating that there existed a 21% potential for increasing farm production (outputs) at the existing level of inputs. The estimated mean allocative efficiency score was 0.76, implying that, on average, there was still a 24% potential for increasing outputs through optimally utilizing farm resources and allocating given inputs. The average economic efficiency score was 0.60, meaning that there was a potential for these farms to increase their capacity to produce more outputs in order to achieve maximum revenue. These results imply that increasing the technical, allocative, and economic efficiencies of the sample farms are all critical requirements.

Regarding the difference in efficiencies among the eight farming systems, the farms growing both cassava and sugarcane as major crops had the highest technical, allocative, and economic efficiency scores compared to the other seven systems, with scores of 1.00, 0.96, and 0.96, respectively. This implies that this farm system was able to maximize outputs at a given quantity of inputs and offers the best opportunity to achieve efficiency. A possible reason for this is that the Thai government had set a pricing policy for both cassava and sugarcane, which might enable farmers to receive a higher price than in a normal year. Additionally, most efficient farms usually planted cassava in the early rainy season and harvest it after it had been calculated for 10 −11 months. This is enable an increase in the storage root yield (starch) and thereby achieved a higher overall yield (DOA, 2008). However, the results also suggested the need to address increasing efficient allocation at the farms in this study area.

Second to farms with major production of both cassava and sugarcane, the farm systems growing cassava or sugarcane as main crops had the next highest scores of economic efficiency compared to the five remaining farms, with scores of 0.76 and 0.70, respectively. However, to achieve full efficiency, the major cassava farms needed to critically improve allocative efficiency, whereas the farms mainly growing sugarcane needed to significantly improve technical efficiency. As for the other farm systems (rice-monoculture crop; mainly growing rice; rice and sugarcane; rice and cassava; and rice, cassava, and sugarcane), these were crucially to improve both technical and allocative efficiencies, including economic efficiency, in order to achieve full efficiency. Most of the sample farms (85%) with low economic efficiency were mainly producing rice as their major crop.

Table 8.3 Technical (TE), allocative (AE) and economic (EE) efficiencies using DEA approach; average for farm types

Farming systems (n)	TE	AE	EE
Rice-monoculture cropping (11)	0.85	0.64	0.54
Mainly growing rice (36)	0.79	0.76	0.59
Mainly growing cassava (3)	0.97	0.78	0.76
Mainly growing sugarcane (6)	0.76	0.92	0.70
Mainly growing cassava and sugarcane (2)	1.00	0.96	0.96
Mainly growing rice and sugarcane (7)	0.67	0.75	0.50
Mainly growing rice and cassava (5)	0.61	0.82	0.52
Rice, cassava and sugarcane (1)	0.79	0.80	0.64
Sample's average	0.79	0.76	0.60

Source: Survey data from August and December 2014

8.4.3 Farm and farmer specific factors causing technical and allocative efficiency

The different human capital and farm characteristics of each of the farms may have an effect on the technical and allocative efficiencies of each farm and its ability to use inputs, farm resources and technologies. Improving our understanding of the determinants of the various efficiency factors was part of our empirical efforts. To this end, we applied the Tobit regression model to estimates factors affecting technical and allocative efficiencies. Examining the results in Table 8.4, *irrigation system* (d_5) appeared to have a positive effect on technical efficiency. *Family labor* (d_3) and *farm size* (d_4) had a positive significant relationship to allocative efficiency, whereas *farm experience* (d_1) appeared to have a negative significant effect on allocative efficiency.

Looking at the *irrigation system* (d_5), accessing more than one irrigation system, meaning not only pond but also underground water and irrigation canals, enabled farmers to achieve a higher yield due to the water being available all year round. Regarding the available water, once the farmers had enough water, they could apply many technologies such as fertilizers, controlling diseases and weeding, which would have a substantial impact on productivity. This then leaded farms to achieve higher technical efficiency. In contrast, the farmers who accessed only farm pond water could not manage their farm production as well due to irregular rainfall. With less water sources, these farmers reduced their inputs, which then means they achieved lower yields and thereby lower efficiency. These results indicate that increasing access to more than one irrigation system encourages farmers to adopt technology, as a result, its leads to increase technical efficiency. Furthermore, among the irrigation systems, access to pond and irrigation canals leaded to full technical efficiency, followed by pond and ground water.

In terms of the relationship between *farm size* (d_4) and allocative efficiency, the results imply that farm size of less than 20 rai was associated with an increase in allocative efficiency. A possible reason for this may be that on small farms, farm activities (e.g., land preparation, transplanting, weeding, and harvesting) require a shorter time than on large farms. This situation made it easier for smaller farmers to conduct farm activities, use optimal inputs, and allocate farm resources efficiently, which then raid farm production.

Regarding *family labor (d_3)*, the results indicate that a greater amount of family labor (man days) was associated with higher levels of allocative efficiency. As family farms with greater available labor were generally operator owned, they rarely used hired labor. Hence, their more intensive management may lead to efficient allocation.

When *farm experience (d_1)* was significant, there was a negative coefficient for allocative efficiency. This implies that intense farm experience was an important factor for inefficient allocation. A possible explanation is that even though farmers had more experiences, their farming experience was particularly involved in the practice and management of paddy farms. As farmers may have initially participated in the activities of rice farms when they were young. For this reason, in recent years, farmers might face difficulties in allocating their farms' resources in a cost-efficient manner with regard to higher input prices, which could lead to more inefficient resource utilization. Furthermore, the more experienced farmers were generally older as well as less education. These farmers may therefore be less willing to adopt new farm practices and apply new technologies as they were close to retirement. Moreover, these older experienced farmers may sometimes have difficulty gathering information as they may not be able to either read or write. They also sometimes had difficulty understanding new techniques as this requires some special skills and the farmers had less experience using modern technologies. Such factors might therefore be the cause of allocative inefficiency. On the other hand, generally, the less experienced farmers were younger farmers and more likely to have greater educational experience or formal education. Such farmers might be more successful in accessing new information and comprehending new practices that could improve their ability to allocate inputs and thereby result in enhanced allocative efficiency.

In terms of *managerial abilities (d_2)* and *farm machines(d_6)*, these shown a positive relationship with technical efficiency, but a negative correlation with allocative efficiency. However, these two variables had no significant effect on the efficiency. Regarding to *managerial abilities*, it might be because this study has measured only one aspect of farmers' abilities with respect to managerial competencies; as a result, this variable shown no significant correlation. However, other aspects of farmers' abilities might affect the level of the efficiency; therefore it will be crucial to measure the remaining abilities in further research.

Table 8.4 Estimating factors of technical and allocative efficiencies

Variables	Technical efficiency		Allocative efficiency	
	Coeff.	Std.Error	Coeff.	Std.Error
Constant	0.689***	0.151	0.827***	0.117
Farm experience (d_1)	0.001	0.002	-0.003**	0.001
Managerial abilities (d_2)	0.025	0.036	-0.017	0.028
Family labor (d_3)	-0.001	0.001	0.001*	0.001
Farm size (d_4)	-0.034	0.050	0.084**	0.038
Irrigation system (d_5)	0.217***	0.063	0.076	0.049
Farm machine (d_6)	0.085	0.073	-0.014	0.056
Log-likelihood	15.7		33.2	

Source: Survey data in August and December 2014
Note: *, **, *** significant at 10%, 5%, 1%

8.5 Summary

Given to the information about outcomes of farmers' management capability, this chapter aims to estimate technical, allocative and economic efficiencies of multiple outputs (i.e., rice, cassava and sugarcane) and to determine the factors associated with technical and allocative efficiencies. The findings revealed that the increasing of technical, allocative and economic efficiencies were significant requirements to consider in this study area. Moreover, the farms growing both cassava and sugarcane as major crops shown the highest technical, allocative, and economic efficiencies, whereas 85% of the sample farms mainly growing rice had lower efficiency. Specifically, the findings point out that access to more than one irrigation system equates to higher levels of technical efficiency; farm size and family labor were positively associated with allocative efficiency, whereas longer farm experience related to lower levels of allocative efficiency.

In order to reduce the rooms of technical and allocative inefficiency, the substantial farm efficiency observed in three major food crops implies that it is crucial to encourage farmers to adopting a system of growing both cassava and sugarcane as major crops, especially with more focusing on planting cassava earlier during the rainy season. Moreover, to specifically increase technical efficiency, the agricultural officer should significantly consider supplying more than one irrigation system such as ground water and irrigation canals, especially in the rain-fed area. This is because even though the farmers have farm ponds, these ponds have provided inadequate water during irregular rainfall in recent years.

Despite the extension officers provides some extension services for promoting more experienced farmers to become better farm practices, this study indicated that these farmers did not allocate farm resources efficiently. To effectively improve their management practices and increase farm efficiency, it is essential to provide the more experienced farmers with specific information on how to efficiently allocate resources and inputs, of which is necessary to highlight due to set up new development programs. As the basic experience of farmers has mainly been involved in rice farm practices. Furthermore, since family labor pay greater attention to improving allocative efficiency on farm, thus all family labor should be highly encouraged to participate in training programs and/or to visit the learning center that is part of agricultural extension services.

Chapter 9
Conclusions

9.1 Summary of main findings

The main objective of this study was to examine the characteristics of the management capability of farmers in Thailand. The motives behind this were to understand the current characteristics of this management capability and to find ways of improving it. This main objective was achieved through the analysis of the specific objectives of the research, as set out in the first chapter. The management capability of farmers was clarified in terms of two major aspects: personal characteristics and decision-making processes.

Overall, the specific objectives were achieved through addressing the following questions:

1. What is the level of managerial ability of farmers, and what are the determinant contributing to it?
2. What are the attitudes of farmers toward farm management and development?
3. How do farmers search for and share agricultural information within their networks?
4. What are the aspects of the decision-making of farmers for agricultural problems?
5. What are the outcomes of farm management performance, measured in terms of production efficiency scores and the factors associated with improving the efficiency?

In this chapter, the answers to these research questions are discussed, and the conclusions which can be drawn regarding the main objective are provided.

9.1.1 The managerial ability of farmers and its determinant factors

The results of a managerial competence test indicated that farmers ranked from moderate to high levels of managerial abilities. Skills found at a high level of ability were risk-oriented, resource-mobilized, decision-making, communication, planning and goal setting. Whereas searching for information, accounting and finance and marketing management skills were found to be at a moderate level. These results imply that the managerial abilities of the farmers require to improve a higher level. Future research is also essential in order to measure other sets of abilities of farmers, with regard to effectively improving their abilities. The findings also highlighted that participating in group activities, household income, the farmer's age and the area of rice cultivated had a significant and positive relationship with an increased level of managerial ability.

9.1.2 Farmers' attitudes toward farm management and farm development

This study examined information on farmers' attitudes toward farm management through analyzing their perspectives within eight attitudinal domains, and by comparing farmers of efficient and inefficient farms. The results indicate that these two types of farmers showed no significant difference with regard to attitudes toward farm management and farm development. Both types of farmers had paid a relatively high attention towards the operation of their farms through the careful consideration of decisions before acting. They were open to new ideas and favored the creation of networks of contacts. In addition, these farmers strongly agreed with aspects related to business orientation, taking financial risks, enjoyment and happiness with being involved in farm activities. The findings also showed that improvements to the quality of farm production and reduction of production costs were significant issues.

9.1.3 Searching and sharing agricultural information within social networks

The findings of this study clearly showed that the primary information networks of the sample farmers were group member and farmers from outside their communities. In addition, the process of farmer-to-farmer learning provided easy access to information, new technology and knowledge. It is, therefore, important to highlight that farmer-to-farmer learning process should be considered during extension offer programs for the transfer of new technology and information. The findings also showed that the high-ability farmers were considered to be central consultants among farmers in the local community, since other farmers believed they could help solve problems and share valuable knowledge.

9.1.4 Farmers' decision-making in agricultural problems

The objectives of this study were to explain why farmers experience different outcomes despite living in the same climate and environment, through an investigation of the decision-making aspects for farmers in regard to agricultural problems. The results indicated that 70% of the farmers considered a problem of severe drought as the most serious and major impact, followed by low sale prices for products. The farmers who viewed a problem as having a major serious effect usually solved the problem in terms of year-to-year decisions as well as took no action to deal with the problems. This suggests that these famers are likely to face the same problems in the future. The results of case studies also show that farmers who managed their farms effectively and viewed problems as a minor or not serious impact decided to deal with problems in the long term. They actively sought out several solutions, analyzed the estimated impacts of solutions before acting, and chose the best solutions for implementation.

9.1.5 Evaluation of technical, allocative and economic efficiencies

To investigate the impacts of the management capability of farmers on farm performance, an evaluation of farm outcomes was conducted through measuring production efficiency. The results show that most farmers experienced production inefficiencies. This implies that it is essential to increase technical, allocative and economic efficiencies for the sampled farms. To do this, the growing of both cassava and sugarcane as major crops is suggested as the best option for farmers. Moreover, the results of a Tobit regression indicated that access to more than one irrigation system (e.g., ground water and irrigation canals) had a positive and significant effect associated with higher technical efficiency. Hence, to successfully increase technical efficiency, the government should consider supplying more than one irrigation system in rain-fed areas, since some farmers did not have enough water during irregular rainfall despite having a farm pond.

9.2 Conclusions and implications

Overall, the findings presented in this study form conclusive evidence that the management capability of small-scale farmers in Thailand is ineffective with regard to the managerial abilities and decision-making for addressing agricultural problems. However, farmers are willing to open to new ideas and technologies in order to develop their farm performance and increase their farm production. Furthermore, the farmer-to-farmer learning process provides a high opportunity for farmers to access to information and new technology easily.

Improvement to farmers' managerial ability is essential because this ability is used every day in performing farm activities. There is also a need to improve the ability of farmers to use inputs in terms of minimum costs, and to produce maximum outcomes with a given set of inputs. A potential approach to improving the management abilities of farmers is the farmer-to-farmer learning process within social networks. As part of this process, farmers can access new knowledge readily, update their information and exchange their experiences. Extension staff should, therefore, consider this idea when they offer programs for transferring new technology and knowledge between farmers in the future. It is also interesting to note that in offering development programs, the extension officer is likely to find a highly cooperative attitude from farmers because the attitudes found in this study affirmed that farmers are open to new ideas and welcome contact with other people.

To achieve effective management capability, improvements to farmers' decision-making is important, since decision-making is a principal activity of farm management, particularly in adopting new technology and seeking information. To enhance the decision-making of farmers, specifically in terms of solving problems, the extension advisor should teach farmers on how to search for new alternatives, evaluate the impacts of alternatives and make decisions as to the best solution for action. The major of farmers rarely undertook these processes when they made decisions to address problems.

Furthermore, even though farmers have effective management capability, they could not apply it efficiently unless they access to sufficient irrigation facilities. Therefore, the government should take action to arrange the supplying more than one irrigation system as a basic goal of development strategy and policy to enhance the maximum farm outcomes for farmers in rain-fed areas in Thailand. This is because farmers frequently face water shortage despite having farm ponds due to irregular rainfall in recent years.

9.3 Suggestions for future research

Several aspects of this research remain in need of further work. The ability of farmers has only been analyzed in terms of managerial competency. In further research, it will be important to measure other aspects of the ability of farmers, such as the 'big five' personality traits, literacy, short-memory and mathematical skills. Regarding the attitudes of farmers, this research has focused solely on attitudes towards farm management. Further studies are, therefore, required in order to investigate further specific sets of farmers' attitudes, such as attitudes to new technologies and attitudes towards risks. This will provide valuable information for the advisory sector in formulating development strategies in response to farmers' goals and attitudes. Finally, the study of farmers' decision-making has considered the process solely in regard to farming problems. It is therefore important to examine other areas of decision-making such as in terms of risks and farm development, and to identify the determinant factors of decision-making.

References

Agarwal, S., Yadav, S.P. and Singh, S.P. (2014): Sensitivity analysis in data envelopment analysis. International Journal of Operational and Research, vol.19, no.12, pp. 174−185.

Alcedo, M.J., Ito, K., Maeda, K. and Barcelo, P. (2013): Farmers' capacity in livestock production and its relation to productivity: the case of goat production in Northeastern Philippines. International Journal of Sustainable Development, vol.6, no.1.

Aldeseit, B. (2013): Measurement of scale efficiency in dairy farms: Data Envelopment Analysis (DEA) approach. Journal of Agricultural Science, vol.5, no.9, pp. 37−43.

Ali, J. and Kumar, S. (2011): Information and communication technologies (ICTs) and farmers' decision-making across the agricultural supply chain. International Journal of Information Management, vol.31, pp. 149−159.

Allahyari, M.S., Mohammad, S.S. and Fatholah, K. (2011): Analyzing farm management skills in Poultry production enterprises in Iran. Life Science Journal, vol.8, pp. 61−67.

Alvarez, A. and Arias, C. (2003): Diseconomies of size with fixed managerial ability. American Journal of Agricultural Economics, vol.85, no.1, pp.134−142.

Andreas, N., Mizuno, K., Schad, I., Pakakrong, M.W. and Franklin, R. (2012): Community-based Microtrade in support of small-scale farmers in Thailand and Tanzania. The Law and Development Review, vol.5, no.1, pp. 79−100.

Assefa, Y., Van den Berg, J. and Conlong, D. E. (2008): Farmers' perceptions of sugarcane stem borers and farm management practices in the Amhara region of Ethiopia. International Journal of Pest Management, vol.54, no.3, pp. 219–226.

Athipanyakul, T. and Pak-Uthai, W. (2012): Determinants of Good Agricultural Practices (GAP) adoption in the chili production system in Northeastern Thailand: A case of participatory approach. International Journal of Environmental and Rural Development, vol.3, no.2, pp. 175–180.

Bank for Agriculture and Agricultural Cooperatives. (2016): Establishment of BAAC in Thailand. Retrieved from http://www.baac.or.th/baac_en/content-about.php?Content_group_sub=0001

Barkema, H.W., Van Der Ploeg, J.D., Schukken, Y.H., Lam, T.J.G.M., Benedictus, G. and Brand, A. (1999): Management style and its association with Bulk milk somatic cell count and incidence rate of Clinical Mastitis. Journal Dairy Sciences, vol.82, pp. 1655–1663.

Barnaud, C., Trébuil, G., Dufumier, M. and Suphanchaimart, N. (2006): Rural poverty and diversification of farming systems in upper Northeast Thailand. Moussons, vol.9-10, pp. 157–187. Retrieved from https://moussons.revues.org/2012

Binam, J.N., Tonyè, J., Wandji, N., Nyambi, G. and Akoa, M. (2004): Factors affecting the technical efficiency among smallholder farmers in the slash and burn agriculture zone of Cameroon. Food policy, vol.29, pp. 531–545.

Bojnec, Š and Latruffe, L. (2007): Measures of farm business efficiency. Industrial Management & Data Systems, vol.108, no.2, pp. 258–270.

Bolfiková, E., Hrehová, D. and Frenová, J. (2010): Manager’s decision-making in organizations-empirical analysis of bureaucratic vs. learning approach. Retrieved from https://www.efri.uniri.hr/sites/efri.hr/files/cr-collections/2/03-hrenova-2010-1.pdf

Borgatti, S., Everett, M. and Freeman, L. (2002): UCINET 6 for windows: Software for Social Network analysis. Analytic Technologies, Lexington, Kentucky, USA.

Borghans, L., Meijers, H. and Weel, T. (2008): The role of noncognitive skills in explaining cognitive test scores. Economic Inquiry, vol.46, no.1, pp. 2−12.

Boyatzis, R.E. (2008): Competencies in the 21st century. Journal of Management Development, vol.27, no.1, pp. 5−12.

Bozoğlu, M. and Ceyhan, V. (2007): Measuring the technical efficiency and exploring the inefficiency determinants of vegetable farms in Samsun province, Turkey. Agricultural Systems, vol.94, pp. 649−656.

Breuer, K., Hemsworth, P.H., Barnett, J.L., Matthews, L.R. and Coleman, G.J. (2000): Behavioural response to humans and the productivity of commercial dairy cows. Applied Animal Behaviour Science, vol.66, pp.273−288.

Brunello, G. and Schlotter, M. (2011): Non cognitive skills and personality traits: Labour market relevance and their development in E&T systems. EENEE Analytical Report No.8. Retrieved from file:///E:/Users/Panatda/Downloads/EENEE_AR8%20(2).pdf

Chaovanapoonphol, Y., George, E.B. and Hui-Shung (Christie), C. (2005): The impact of rural financial services on the technical efficiency of rice farmers in the upper North of Thailand. Paper presented at the Annual Conference of the Australian Agricultural and Resource Economics Society at Coffs Harbour. Retrieved from http://ageconsearch.umn.edu/bitstream/137811/2/2005_chaovanapoonphol.pdf

Charnes, A., Cooper, W.W. and Rhodes, E. (1978): Measuring the efficiency of decision making units. European Journal of Operational Research, vol.2, pp. 429−444.

Chong, E. (2011): Managerial competencies and career advancement: A comparative study of managers in two countries. Journal of Business Research, pp. 1−9.

Coelli, T., Rao, D., O'Donnell, C. and Battese, G. (2005): An introduction to efficiency and productivity Analysis. 2nd edit, Springer, New York.

Coelli, T., Rahman, S. and Thirtle, C. (2002): Technical, allocative, cost and scale efficiencies in Bangladesh rice cultivation: A non-parametric approach. Journal of Agricultural Economics, vol.53, no.3, pp. 607−626.

Coelli, T.J. (1995): Recent development in frontier modeling and efficiency measurement. Australian Journal of Agricultural Economics, vol.39, no.3, pp. 219−245.

Colom, R., Rebollo, I., Palacios, A., Juan-Espinosa, M. and Kyllonen, P.C. (2004): Working memory is (almost) perfectly predicted by g. Intelligence, vo.32, pp. 277−296.

Cunha, F., Heckman, J.J., Lochner, L. and Masterov, D.V. (2005): Interpreting the evidence on life cycle skill formation. NBER Working Paper Series. Retrieved from http://www.nber.org/paper/w11331.pdf

Dağistan, E. (2010): Determination of technical efficiency in wheat (*Triticum aestivum L.)*production of Turkey: A case study of Cukurova region. Journal of Food, Agriculture & Environment, vol.8, no.2, pp. 354−358.

Department of Agriculture (DOA), 2008: How to produce cassava at the maximum yield. Pibai Journal, vol.11, no.2. Retrieved from http://www.doa.go.th/pibai/pibai/n11/v_11-mar/jakfam2.html

DOAE (2012): The number of farm household in Thailand in 2008−2012. Retrieved from http://www.agriinfo.doae.go.th/5year/general/51-55/farmer51-55.pdf

DOAE (2013): Income and expenditure of farm household in 2010-2011. Retrieved from http://www.agriinfo.doae.go.th/5year/general/50-54/income50-54.pdf

Dhungana, B.R., Nuthall, P.L. and Nartea, G.V. (2004): Measuring the economic inefficiency of Nepalese rice farms using data envelopment analysis. The Australian Journal of Agricultural and Resource Economics, vol.48, no.2, pp. 347−369.

Edwards-Jones, G. (2006): Modelling farmer decision-making: Concepts, progress and challenges. Animal Science, vol.82, no.6, pp. 783−390.

FAO (2001): Crop diversification in Thailand. Retrieved from http://www.fao.org/docrep/003/x6906e/x6906e0c.htm#CROP%20DIVERSIFICATION%20IN%20THAILAND%20Chavalvut%20Chainuvati*%20and%20Withaya%20Athipanan**

Farrell, M.J. (1957): The measurement of production efficiency. Journal of the Royal Statistical Society, Series A, vol.120, no.3, pp. 253−290.

Ferruz, L., Muñoz, F. and Vargas, M. (2012): Managerial abilities: Evidence from religious mutual fund managers. Journal of Business Ethics, vol.105, no.4, pp. 503−517.

Ford, S.A. and Shonkwiler, J.S. (1994): The effect of managerial ability on farm financial success. Agricultural and Resource Economic Review, pp. 150−157.

Frese, M., Goldstein, M., Kilic, T. and Montalvao, J. (2015): Female non-cognitive skills and cash crop adoption: Evidence from rural Malawi. Retrieved from https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=CSAE2016&paper_id=1077

Galanopoulos, K., Aggelopoulos, S., Kamenidou, I. and Mattas, K. (2006): Assessing the effects of managerial and production practices on the efficiency of commercial pig farming. Agricultural Systems, vol.88, pp. 125−141.

Gaurav, S. and Singh, A. (2012): An inquiry into the financial literacy and cognitive ability of farmers: Evidence from rural India. Oxford Development studies, vol.40, no.3, pp. 358–380.

Glewwe, P., Huang, Q. and Park, A. (2013): Cognitive skills, noncognitive skills, and the employment and wages of young adults in rural China. Retrieved from https://www.apec.umn.edu/sites/apec.umn.edu/files/cognitive_skills_noncognitive_skills_and_the_employment_and_wages.pdf

Goleman, D. (2014): Leadership that gets results. Retrieved from http://leadership4lawyers.com/wp-content/uploads/2014-12-04-Article-Summary01-Leadership-That-Gets-Results-by-Daniel-Goleman-FIN.pdf

Haji, J. (2006): Production efficiency of smallholders' vegetable-dominated mixed farming system in Eastern Ethiopia: A non-parametric approach. Journal of African Economies, vol.16, no.1, pp. 1–27.

Haneishi, Y., Maruyama, A., Takagaki, M. and Kikuchi, M. (2014): Farmers' risk attitudes to influence the productivity and planting decision: A case of rice and maize cultivation in rural Uganda. African Journal of Agricultural and Resource Economics, vol.9, no.4, pp. 309–322.

Hansson, H. and Ferguson, R. (2011): Factors influencing the strategic decision to further develop dairy production: A case of farmers in central Sweden. Livestock Science, vol.135, pp. 110–123.

Hansson, H. (2008): How can farmers managerial capacity contribute to improved farm performance? A case study of dairy farms in Sweden. Acta Agriculturae Scandinavica, Section C- Food Economic, vol.5, pp. 44–61.

Hansson, H. and Öhlmér, B. (2008): The effect of operational managerial practices on economic, technical and allocative efficiency at Swedish dairy farms. Livestock Science, vol.118, pp. 34–43.

Hatcher, J., Snowling, M.J. and Griffiths, Y.M. (2002): Cognitive assessment of dyslexic students in higher education. British Journal of Educational Psychology, vol.72, pp. 119-133.

Heckman, J.J. (2007): The economics, technology, and neuroscience of human capability formation. Retrieved from http://www.pnas.org/cgi/doi/10.1073/pnas.0701362104

Heckman, J.J., Stixrud, J. and Urzua, S. (2006): The effects of cognitive and noncognitive abilities on labor market outcomes and social behavior. NBER Working Paper Series. Retrieved from http://www.nber.org/papers/w12006.pdf

Hellin, J., Mark, L. and Madelon, M. (2009): Farmer organization, collective action and market access in Meso-America. Food Policy, vol.34, pp. 16−22.

Hoang, L.A., Castella, J.C. and Novosad, P. (2006): Social networks and information access: Implications for agricultural extension in a rice farming community in northern Vietnam. Agriculture and Human Values, vol.23, pp. 513–527.

Idiong, I.C. (2007): Estimation of farm level technical efficiency in smallscale Swamp rice production in cross river state of Nigeria: A stochastic frontier approach. World Journal of Agricultural Sciences, vol.3, no.5, pp. 653−658.

Isaac, M.E., Erickson, B.H., Quashie-San, S.J. and Timmer, V.R. (2007):Transfer of knowledge on agroforestry management practices: The structure of farmer advice network. Ecology and Society, vol.12, no.2 (32). Retrieved from http://www.ecologyandsociety.org/vol12/iss2/art32/

Jha, R., Chitkara, P. and Gupta, S. (2000): Productivity, technical and allocative efficiency and farm size in wheat farming in India: A DEA approach. Applied Economics Letters, vol.7, pp.1−5.

Jitsanguan, T. (2001): Sustainable agricultural systems for small-scale farmers in Thailand:implications for the environment. Retrieved from www.fftc.agnet.org

Jessop, R., Diallo, B., Duursma, M., Mallek, A., Harms, J. and Manen, B.V. (2012): Creating access to agricultural finance: Based on a horizontal study of Cambodia, Mali, Senegal, Tanzania, Thailand and Tunisia. Retrieved from http://www.afd.fr/jahia/webdav/site/afd/shared/PUBLICATIONS/RECHERCHE/Scientifiques/A-savoir/14-VA-A-Savoir.pdf

Jonathan, R. and Sakunee, N. (2001): Embracing the global in Thailand: Activism and Pregmatism in an Era of Deagrarianization. World Development, vol.29, no.6, pp. 945−960.

Kahan, D. (2012): Entrepreneurship in farming. Food and Agriculture Organization of the United Nations. Rome, Italy.

Kahan, D. (2013): Managing risk in farming. 2nd edit, Food and Agriculture Organization of the United Nations. Rome, Italy.

Kay, R.D., Edwards, W.M. and Duffy, P.A. (2016): Farm management. 8th edit, McGraw-Hill Education, New York.

Keenan, J.M., Betjemann, R.S. and Olson, R.K. (2008): Reading comprehension tests vary in the skills they assess: Differential dependence on decoding and oral comprehension. Scientific Studies of Reading, vo.12, no.3, pp. 281−300.

Khai, H.V. and Yabe, M. (2011): Technical efficiency analysis of rice production in Vietnam. Journal of International Society for Southeast Asian Agricultural Sciences, vol.17, no.1, pp. 135−146.

Kirkley, J., Squires, D. and Strand, I.E. (1998): Characterizing managerial skill and technical efficiency in a fishery. Journal of Productivity Analysis, vol.9, pp. 145−160.

Krasachat, W. (2012): Organic production practices and technical inefficiency of durian farms in Thailand. Procedia Economics and Finance, vol.3, pp. 445−450.

Krasachat, W. (2004): Technical efficiencies of rice farms in Thailand: A non-parametric approach. Journal of American Academy of Business, Cambridge, vol.4, pp.37−46.

Laajaj, R. and Macours, K. (2015): Cognitive, non-cognitive, and technical skills of poor rural farmers: Measurement challenges and implications. Retrieved from http://siteresources.worldbank.org/INTLSMS/Resources/3358986-1239390183563/LSMS_Skills_Presentation_April2015.pdf

Latruffe, L., Balcombe, K., Davidova, S. and Zawalinska, K. (2005): Technical and scale efficiency of crop and livestock farms in Poland: Does specialization matter? Agricultural Economics, vol.32, pp. 281−296.

Lawrence, B.O. (2011): Determinants of managerial abilities of small scale coco a farmers: A kinyele Lga of Oyo State of Nigeria. ARPN Journal of Agricultural and Biological Science, vol.6, no.10, pp. 17−25.

Lee, B. (2015): Prolonged Thailand drought threatens global rice shortage. Sci Dev. Net's South-East Asia & Pacific. Retrieved from http://www.scidev.net/asia-pacific/agriculture/news/prolonged-thailand-drought-threatens-global-rice-shortage.html

Li, L., Tsunekawa, A., Tsubo, M., Koike, A. and Wang, J. (2010): Efficiency and its determinant factors for smallholder farms in the grain for green program on the Loess Plateau, China. Journal of Food, Agriculture & Environment, vol.8, no.3&4, pp. 772−778.

Long, B. (2013): Understanding farmer decision making and adoption behavior. Retrieved from https://grdc.com.au/Research-and Development/GRDC-Update-Papers

Marks, D. (2011): Climate change and Thailand: Impact and response. Contemporary

Southeast Asia, vol.33, no.2, pp. 229-258.

Matuschke, I. and Qaim, M. (2009): The impact of social networks on hybrid seed adoption in India. Agricultural Economics, vol.40, pp. 493−505.

Mburu, S., Ackello-Ogutu, C. and Mulwa, R. (2014): Analysis of economic efficiency and farm size: A case study of wheat farmers in Nakuru district, Kenya. Economics Research International, pp. 1−10.

McBride, W.D. and Johnson, J.D. (2006): Defining and characterizing approaches to farm management. Journal of Agricultural and Applied Economics, vol.38, no.1, pp. 155−167.

McLean-Meyinsse, P.E. and Brown, A. (1994): Survival strategies of successful Black farmers. The review of Political Economy. Spring, vol.22, no.4, pp. 73−83.

Mondal, S., Haitook, T. and Simaraks, S. (2014): Farmers' knowledge, attitude and practice toward organic vegetables cultivation in Northeast Thailand. Kasetsart Journal Social Sciences, vol.35, no.1, pp. 158−166.

Mukiama, B.K., Suphanchaimat, N. and Sriwaranun, Y. (2014): Factors influencing vegetable farmer's choice of marketing channel in Khon Kaen, Thailand. Khon Kaen Agriculture Journal, vol.4, pp. 595−609.

Nagayets, O. (2005): Small farms: Current status and key trends. Retrieved from http://Citeseerx.ist.psu.edu/

Nell, G.P., Botha, C.A.J. and Groenewald, J.A. (1998): Managerial ability and farming success: An analysis of small farmers at the Maktini scheme. South African Journal of Agricultural Extension, vol.27, pp. 45−59.

Northeastern Meteorological Center (Upper Part) (2016): Rainfall amount and distribution pattern in Upper Northeastern region during 2000−2013. Retrieved from http://www.khonkaen.tmd.go.th/it/rain_year.html

Nuthall, P. (2011): Understanding managerial ability, critical factors and their improvement. Proceeding of 18th International Farm Management Congress Methven, New Zealand, vol.3, pp. 324 − 334. Retrieved from www.ifmaonline.org

Nuthall[a], P.L. (2010): Farm business management: The core skills. CPI Antony Rowe, Chippenham, UK

Nuthall[b], P.L. (2010): Farm business management: The human factor. CPI Antony Rowe Ltd., UK

Nuthall[a], P.L. (2009): Modelling the origins of managerial ability in agricultural production. The Australian Journal of Agricultural and Resource Economics, vol.53, no.3, pp. 413−436.

Nuthall[b], P.L. (2009): Managerial factors in primary production: data from a sample of New Zealand farmers with an emphasis on experience as a factor in success. AERU Research Report No. 315, Lincoln University, Canterbury. Retrieved from www.lincoln.ac.nz.

Nuthall, P.L. (2006): Determining the important management skill competencies: the case of family farm business in New Zealand. Agricultural Systems, vol.88, pp. 429−450.

Nuthall, P. (2002): Managerial competencies in primary production: the review of consultants and other professionals. FHMG Research Report 03/2002, Farm and Horticultural Management Group, Lincoln University. Retrieved from https://researcharchive.lincoln.ac.nz/bitstream/handle/10182/53/fhmg02-04.pdf?sequence=1.

Nuthall. P.L. (2001): Managerial ability-a review of its basic and potential improvement using psychological concepts. Agricultural Economics, vol.24, pp. 247−262.

NSTDA (2011): Agriculture and food. Retrieved from http://nstda.or.th/eng/index.php/research/foods-and-agriculture

Odongo, J.A. and Muhua, G.O. (2015): Modelling the relationship between farmer's attitude towards farming and farm practices: A case study of smallholder farmers in Tanzania. European Scientific Journal, vol.11, no.36, pp. 164−180.

Office of Agricultural Economics (OAE). (2014): Agricultural statistics of Thailand 2014. Retrieved from http://oae.go.th/download_journal/2558/yearbook57.pdf

Öhlmér, B., Olson, K. and Brehmer, B. (1998): Understanding farmers' decision making processes and improving managerial assistance. Agricultural Economics, vol.18, pp. 273−290.

Olson, K.D. (2004): Farm management Principles and strategies. Iowa State Press, USA.

Palacios, S.P.I. (2005): Farmers' attitudes towards sustainable agriculture in Japan. Japanese Studies, vol.25, no.2, pp.187−202.Perea, J., Pablos-Heredero, C., Angón, E., Giorgis, A., Barba, C. and García, A. (2014):

Using farmer decision-making profiles and managerial capacity as predictor of farm viability in argentinean dairy farms (La Pampa). Revista Científica, ResearchGate, pp. 509−517. Retrieved from http://www.researchgate.net/publication/279330717

Phelan, C. and Sharpley, R. (2012): Exploring entrepreneurial skills and competencies in farm tourism. Retrieved from http://www.ntu.ac.uk/nbs/document_uploads/109323.pdf

Pillay, R. (2008): Managerial competencies of hospital managers in South Africa: A survey of managers in the public and private sectors. Human Resources for Health, vol.6, no.4, pp. 1−7.

Polthanee, A., Promkhumbut, A. and Bamrungrai, J. (2014): Drought impact on rice production and farmers’ adaptation strategies in Northeast Thailand. International Journal of Environmental and Rural Development, vol.5, no.1, pp. 45−52.

Porcelli, F. (2009): Measurement of technical efficiency: A brief survey on parametric and non-parametric techniques. Retrieved from file:///E:/Users/Panatda/Downloads/TECHNICAL%20EFFICIENCY.pdf

Portugal, A.D. and Jones, J.G.W. (1984): The managerial capacity of farmers and the development of a cattle industry: Part 1-background and concepts. Agricultural Systems, vol.14, pp. 65−80.

Poungchompu, S., Kobayashi, T. and Supawadee, C. (2013): Factors affecting farmers’ decisions on utilization of rice straw compost in Northeastern Thailand. Journal of Agriculture and Rural Development in the Tropics and Subtropics, vol.114, no.1, pp. 21-27.

Rahman, S., Aree, W., Songsak, S. and Yaovarate, C. (2009): Production efficiency of Jasmine rice producers in Northern and North-eastern Thailand. Journal of Agricultural Economics, vol.60, no.2, pp. 419−435.

Rajčániová, P.B.M. (2004): Scale efficiency of agricultural enterprises in Slovakia. Agricultural Economics, vol.50, no.8, pp.331−335.

Ray, S.C. (2004): Data Envelopment Analysis. 1st publish, the Press Syndicate of the University of Cambridge, United Kingdom.

Research and Development Institute. (2007): Final report of the Project for Revitalization of the Deteriorated Environment in the Land Reform Areas through Integrated Agricultural Development (Stage 1). Khon Kaen University, Thailand.

Rhone, J.A., Koonawootrittriron, S. and Elzo, M.A. (2008): Record keeping, genetic selection, educational experience and farm management effects on average milk yield per cow, milk fat percentage, bacterial score and bulk tank somatic cell count of dairy farms in the central region of Thailand. Tropical Animal Health and Production, vol.40, no.8, pp. 627−636.

Rougoor, C.W. (1999): Management, milk production level and economic performance: An explorative study on dairy farms. Ph.D. dissertation, Wageningen University. Retrieved from http://edepot.wur.nl/136046

Rougoor, C.W., Trip, G., Huirne, R.B.M. and Renkema, J.A. (1998): How to define and study farmers' management capacity: Theory and use in agricultural economics. Agricultural Economics, vol.18, no.3, pp. 261−272.

Sadati, S.A., Fami, H.S., Asadi, A. and Sadati, S.A. (2010): Farmers' attitude on sustainable agriculture and its determinants: A case study in Behbahan country of Iran. Research Journal of Applied Sciences, Engineering and Technology, vol.2, no.5, pp. 422−427.

Samah, B.A., D'Silva, J.L., Shaffril, H.A.M., Man, N. and Azman, A. (2012): Malaysian contract farmers' attitude towards sustainable agriculture. Journal of Basic and Applied Scientific Research, vol.2, no.9, pp. 9205−9210.

Seeniang, P. and Thaipakdee, S. (2013): Key success factors and constraints of organic vegetable production systems in Thailand: Lessons learned from selected cases of best practices. Kasetsart Journal Social Sciences, vol.34, no.1, pp. 162−170.

Shamsudin, M.N., Taraka, K., Latif, I.A. and Sidique, S.A. (2011): Estimation of technical efficiency for rice farms in Central Thailand using stochastic frontier approach. Asian Journal of Agriculture and Development, vol.9, no.2, pp. 1−11.

Smallwood, N. and Ulrich, D. (2004): Capitalizing on capabilities. Harvard Business

Review. Retrieved from http://rbl.net/images/uploads/rbl_programs/Capitalizing_on_Capabilities.pdf

Solano, C., León, H., Pérez, E., Tole, L., Fawcett, R.H. and Herrero, M. (2006): Using farmer decision-making profiles and managerial capacity as predictors of farm management and performance in Costa Rican dairy farms. Agricultural Systems, vol.88, pp. 395–428.

Solano, C., León, H., Pérez, E. and Herrero, M. (2003): The role of personal information sources on the decision-making process of Costa Rican dairy farmers. Agricultural Systems, vol.76, pp. 3–18.

Solano, C., León, H., Pérez, E. and Herrero, M. (2001): Who makes farming decisions? A study of Costa Rican dairy farmers. Agricultural Systems, vol.67, pp. 181–199.

Sriboonchitta, S. and Wiboonpongse, A. (2005): On the estimation of stochastic production frontiers with self-selectivity: Jasmine and Non-Jasmine rice in Thailand. Chiang Mai University Journal, vol.4, no.1, pp. 101–108.

Srisompun, O., Kaoint, S., Khongritti, W. and Songsrirod, N. (2013): An analysis on the efficiency of glutinous rice production in different cropping systems: The case of rainfed area in Northeast Thailand. Asian Journal of Agricultural Research, vol.7, no.1, pp. 26–34.

Srisompun, O. and Isvilanonda, S. (2012): Efficiency change in Thailand rice production: Evidence from panel data analysis. Journal of Development and Agricultural Economics, vol.4, no.4, pp. 101–108.

Tatlonghari, G., Paris, T., Siliphouthone, I. and Suhaeti, R. (2012): Seed and information exchange through social networks: The case of rice farmers of Indonesia and Lao PDR. Sociology Mind, vol.2, no.2, pp. 169–176.

Thida, C.H. and Ito, S. (2008): Study on international competitiveness in rice exports under high oil price: U.S., Japan, Thailand, Vietnam and Myanmar. The 8th study conference of the Farm Management Society of Japan (FMSJ), on September 20-22, 2008, at faculty of agriculture, Tottori University, pp. 238−239.

Timprasert, S., Datta, A. and Ranamukhaarachchi, S.L. (2014): Factors determining adoption of integrated pest management by vegetable growers in Nakhon Ratchasima province, Thailand. Crop Protection, vol.62, pp. 32−39.

Trinder, J.C. (2008): Competency standards: A measure of the quality of a workforce. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, pp. 165−168. Retrieved from http://www.isprs.org/XXXVII/congress/6a_pdf/5_WG-VI-5/01.pdf

Trip, G., Thijssen, G.J., Renkema, J.A. and Huirne, R.B.M. (2002): Measuring managerial efficiency: The case of commercial greenhouse growers. Agricultural Economics, vol.27, pp. 175−181.

Todsadee, A., Kameyama, H., Ngamsomsuk, K. and Yamauchi, K. (2012): Technical efficiency of boiler farms in Thailand: Data envelopment analysis (DEA) approach. Retrieved from http://www.ag.kagawa-u.ac.jp/kameyama/2012_G_DEA_broiler_cbetm2012.pdf

Totterdell, P., Holman, D. and Hukin, A. (2008): Social networkers: Measuring and examining individual differences in propensity to connect with others. Social networks, vol.30, pp. 283−296.

Umanath, M. and Rajasekar, D.D. (2013): Estimation of technical, scale and economic efficiency of paddy farms: A Data Envelopment Analysis approach. Journal of Agricultural Science, vol.5, no.8, pp. 243−251.

Utaranakorn, P. and Yasunobu, K. (2015): Farm managerial competency level of farmers in Northeastern Thailand: A case study on farmers in Khon Kaen Province. Japanese Journal of Farm Management, vol.52, no.4, pp. 43−48.

Villano, R. and Fleming, E. (2006): Technical inefficiency and production risk in rice farming: Evidence from Central Luzon Philippines. Asian Economic Journal, vol.20, no.1, pp. 29−46.

Vukelić, N. and Rodić, V. (2014): Farmers' management capacities as a success factor in agriculture: A review. Economics of Agriculture, vol.61, no.3, pp. 805−814.

Waiblinger, S., Menke, C. and Coleman, G. (2002): The relationship between attitudes, personal characteristics and behavior of stockpeople and subsequent behavior and production of dairy cows. Applied Animal Behaviour Sciences, vol.79, pp. 195−219.

Williams, R.S., Ari, O. and Santamaria, C.N. (2011): Measuring college students' reading comprehension ability using cloze tests. Journal of Research in Reading, vol.34, no.2, pp. 215−231.

Willock[b], J., Deary, I.J., Edwards-Jones, G., Gibson, G.J., MacGregor, M.J., Sutherland, A., Dent, J.B., Morgan, O. and Grieve, R. (1999): The role of attitudes and objectives in farmer decision-making: Business and environmentally-oriented behavior in Scotland. Journal of Agricultural Economics, vol.50, no.2, pp. 286−303.

Willock[a], J., Deary, I.J., McGregor, M.M., Sutherland, A., Edwards-Jones, G., Morgan, O., Dent, B., Grieve, R., Gibson, G. and Austin, E. (1999): Farmers' attitudes, objectives, behaviors, and personality traits: The Edinburgh study of decision making on farms. Journal of Vocational Behavior, vol.54, pp. 5−36.

Wilson, P., Hadley, D. and Asby, C. (2001): The influence of management characteristics on the technical efficiency of wheat farmers in eastern England. Agricultural Economics, vol.24, pp. 329−338.

Winai, M. (2015): New farmer development in agricultural land reform area in Thailand. Food & Fertilizer Technology Center. Retrieved from http://ap.fftc.agnet.org/ap_db.php?id=451

Wirongrong, D., Schmidt-Vogt, D. and Shretha, R.P. (2015): Farmers' land use decision-making in the context of changing land and conservation policies: A case study of Doi Mae Salong in Chiang Rai Province, Northern Thailand. Land Use Policy, vol.48, pp. 179-189

Yarmohamadi, Z., Samani R.E., Poursaeed, A. and Vahedi, M. (2014): The factors affecting ability of wheat farmers risk management in Iran (case study: Ilam province). International Journal of Plant, Animal and Environmental Sciences, vol.4, no.2, pp. 701−705.

Zimmerman, E.K., Holden, L.A., Park, J.E. and Hyde, J. (2006): Relationship of dairy producer management styles to overall return on assets. Journal of Extension, vol.44, no.6. Retrieved from http://www.joe.org/joe/2006december/rb6.php

Appendix

Figure A.1 Experiences of decision events making by Farmer A

Year	19	66 19	76 19	86 19	96 20	06	2016
Farmer's age	2	0 3	0 4	0 5	0 6	0	71
Farmer's life (school - present)	7 11 Elementary school	25 27 Married 1st	2nd 33 35 3rd 4th Children		Severe drought		1st daughter: Local government officer 2nd daughter: Farmer 3rd daughter: Farmer 4th son: Industrial worker
Status of farmer	Part time farmer (help mother working on farm)	26 Full	time farmer				3rd daughter assist Farmer A and wife to work on farm (growing rice and vegetables) and sell farm products
Farm land & activities		62 rai			59 Reshape farmland	64 Buying new farmland (9 rai)	Having farmland totally 71 rai
Crop cultivation	*1* Growing rice (23 rai), cassava & sugarcane (33 rai), jute (6 rai)*	1*		49 Growing mango	54 Growing vegetables	68 Growing organic vegetables	Following integrated farming (rice, cassava, sugarcane, vegetables & fruit)
Farm machine for land preparation			Animal power (buffalo)	Tiller 1	51 Tiller 2		Using Tiller 2 for land preparation only
Water sources		Rainfall			Pond 1 (ALRO&JICA) & underground water	67 Pond 2	Mainly using underground water
Livestock		Feed	Buffalo (n=8)		Sold all buffalo		Feed cow (n=24)
Farmers' group/ agricultural organization	*2* Visit learning center; 3* Join organic vegetable group; 4* Cattle group*					69 2*, 3*, 4*	

Figure A.2 Experiences of decision events making by Farmer B

Year	19	71 19	81 19	91 20	01 20	11	2016
Farmer's age	2	0 3	0 4	0 5	0 6	0	66
Farmer's life (school - present)	7 12 14 Elementary school	25 27 1st 2nd 3rd Married Children			56 57 Working in Bangkok	62 Severe drought	1st daughter: recycle collector 2nd daughter: Farmer 3rd son: industrial worker
Status of farmer	Part time farmer (help parents working on farm)	Full	time farmer				
Farm land & activities		19 rai	34 Buying new farmland (5 rai)				Having farmland totally 24 rai
Crop cultivation	*1* Growing rice (10 rai) & jute (9 rai);* *2* Growing rice (6 rai), cassava/sugarcane (12 rai), jute (6 rai)*	1*	2*		59	Applying integrated farming	Integrated farming system: rice (6 rai), cassava (6 rai), sugarcane (10 rai), vegetables (1 rai), pond (1 rai)
Farm machine for land preparation			35 Tiller Animal power (buffalo)			65 Tractor	Using Tiller and tractor for land preparation
Water sources		Rainfall			Irrigation canal	Pond (ALRO&JICA)	Mainly using water from irrigation canal
Livestock		Feed	buffalo (n=3) Cow (n=2)		Sold all cattle		
Farmers' group/ agricultural organization						Join organic vegetable group	

Figure A.3 Experiences of decision events making by Farmer C

Year	19	73 19	83 19	93 20	03 20	13	2016
Farmer's age	2	0 3	0 4	0 5	0 6	0	64
Farmer's life (school - present)	7 12 Elementary school	23 27 1st 2nd 3rd Married Children	34	Part time job (building house: 120-130 B/day)	51	Severe drought	1st daughter: Local government officer 2nd daughter: Farmer 3rd daughter: Industrial worker
Status of farmer	Part time farmer (help parents working on farm)		Full time farmer				2nd daughter assist Farmer A and wife to work on farm (growing rice and vegetables) and sell farm products
Farm land & activities			25 rai	42 Buying new farmland (17 rai)	52 Reshape farmland		Having farmland totally 42 rai
Crop cultivation	*1* Growing rice (15 rai) & cassava (10 rai)*		1*	Growing sugarcane		61 Applying integrated farming	Following integrated farming (rice, cassava, sugarcane, vegetables and fruit) & planting sweet potato & growing mushroom
Farm machine for land preparation			Animal power (buffalo)	41 Tiller 1	57 Tiller 2		Using Tiller 2 for land preparation only
Water sources	*2* Renovated pond 1*		Rainfall & pond 1 (ALRO&JICA)	Pond 2 2* (Cooperative)		Underground water	Mainly using underground water & adopting drip irrigation system
Livestock			Feed buffalo (n=8)	Sold all buffalo	Feed cow (n=7) Sold cow		
Farmers' group/ agricultural organization	*3* Join organic vegetable group*					3*	Visiting learning center,

Figure A.4 Experiences of decision events making by Farmer D

Year	19	71 19	81 19	91 20	01 20	11	2016
Farmer's age	2	0 3	0 4	0 5	0 6	0	66
Farmer's life (school - present)	6 10 14 Elementary school High school	21 23 27 1* 2* 1^{st} College *1* teacher;* *2* married*	31 38 2^{nd} Children B.A. degree		52 58 Master degree 3* *3* teacher retirement*	63 Severe drought	Retirement teacher 1^{st} son: Middleman 2^{nd} daughter: Lawyer
Status of farmer	Part time farmer (help parents working on farm)	24 Part time farmer on own farm			59	Full time farmer	
Farm land & activities		12 rai				Buying new farmland (9 rai) & reshape farmland	Having farmland totally 21 rai
Crop cultivation	*4* Growing rice & cassava*	4*				Applying integrated farming	Following integrated farming (rice, cassava, bamboo, banana & fruit)
Farm machine for land preparation		Animal power (buffalo)	Tiller				Hired tractor and tiller for land preparation
Water sources	*5* Using water from irrigation canal*	Rainfall		41 Pond 1 (Teacher cooperative)	5*	Pond 2 (ALRO&JICA) & renovated pond 1	Mainly using water from irrigation canal by pumping and storing to tank
Livestock	19	Feed buffalo & cow			Sold all cattle		
Farmers' group/ agricultural organization	*6* visit learning center;* *7* Join organic vegetable group*			44 6*		61 7*	

Figure A.5 Experiences of decision events making by Farmer E

Year	20	02 20	12	2016
Farmer's age	2	0 3	0	35
Farmer's life (school - present)	5 10 13 16 18 Elementary school 1* 2* *1* Junior high school;* *2* High school*	23 25 B.A. degree Married Dental assistance (15,000-28,000 B/month)	33 Severe drought	
Status of farmer			Full time farmer	Interested in New theory farming and integrated farming
Farm land & activities		Reshape farmland	48 rai	Having farmland totally 48 rai
Crop cultivation			Applying integrated farming	Following integrated farming system: rice (25 rai), cassava (10 rai), sugarcane (4 rai), *vegetables (5 rai), pond (3 rai) & hut (1 rai) *Decreasing vegetables' area to growing sweet corn
Farm machine for land preparation			Tiller	Sometime hired tractor for
Water sources			Pond & underground water	Mainly using water from pond by using water pump & adopting drip irrigation system
Livestock			Chicken	Mainly for home consumption
Farmers' group/ agricultural organization	*3* visit learning center;* *4* Join organic vegetable group*		3* & 4*	

A Study on the Characteristics of Farmers' Management Capability in Thailand

Thesis Summary

Management capability is the fourth major agricultural input and plays an important role in managing other three important inputs: land, labor and capital. Improving management capability is one potential solution described in literature for farmers to thrive in the changing economic and climate environments. To improve farmers' capability, it firstly needs to be a good understanding of the characteristics of farmers' management capability. However, there has been no clear definition of what it means in case of Thailand' s farmers so far, as previous studies have used several varying methods to capture it. In addition, many studies in Thailand have only measured part of farm outcomes such as profitability, efficiency and satisfaction of farmers to find out the best way to develop agricultural production and farmers' livelihood. Accordingly, it is significant to study this issue and address this gap in research. Therefore, the objective of this study is to clarify the characteristics of farmers' management capability in Thailand. This characteristic is analyzed by following two aspects: "personal characteristics" and "decision-making". In addition, this study confirm the relationship between farmers' management capability and farm outcomes of farmers.

To achieve the objective, this study used farm-level data obtained from interviewing family based farmers in five rural villages of Khon Kaen Province, using the structured questionnaires. The farmers were purposive randomly selected and interviewed several times from August 2012 to August 2016. One of the criteria to select the farmers was that they had at least one farm pond and their farms were similar in terms of soil fertility.

With regard to personal characteristics, this study highlighted two points: farmers'

abilities and farmers' attitudes. To measure the level of farmers' ability, nine skills of noncognitive ability via managerial competency was employed. The findings showed that farmers' perception of managerial abilities ranked at a high level for risk oriented, resource mobilized, decision-making, communicative, and planning and goal setting skills. On the other hand, at the moderate level their ability varied for information searching, accounting and financial management, and marketing management. To find out the factor contributing to improve farmers' ability, the results of multiple regression analysis show that participation in group activities had a positively and significant relationship with the ability of accounting and financial management, marketing management, and planning and goal setting. Moreover, household income had a strong positive correlation with information searching skills and farmer's age was positively related to decision-making skills. Area of rice cultivation also had a positive associated with increasing planning and goal setting skills.

Farmers' attitudes toward farm management and farm development were analyzed by comparing between farmers with efficient and inefficient farms. The results show that there was no significant difference in attitudes of farmers with efficient and inefficient farms. Both types of farmers paid more attention to farm performance, were open to more ideas and business orientation, took financial risks, enjoyed and were happy doing on-farm activities without having any stress. In addition, the farmers agreed that improving the quality of farm production and reducing production cost were the most significant issues for their farm development.

According to the aspects of decision-making, this study presented the results regarding the processes of farmers' searching and sharing agricultural information and farmers making decision in agricultural problems. The results on acquiring information reveal that the process of farmer-to-farmer learning within their social networks gave farmers easily access to agricultural information. In addition, high-ability farmers were becoming the centers of consultations among farmers in the local community. This is because farmers felt more comfortable to discuss their agricultural matters with local networks than those they deem to be non-locals. The high-ability farmers also preferred to share their knowledge and technology to encourage other connectors.

The findings of farmers making decision show that the major serious problem defined by farmers was severe drought, followed by a problem of receiving low prices for selling products. A half of farmers with detecting problems as major serious chose solutions for problems by year-to-year decision, implying these farmers are likely to face the same problems again. In contrast, those farmers with problems termed as minor or not serious made decision to overcoming the problem for long term by searching several solutions, analyzing the impacts of the solutions and choosing the best way for implementing on farm. This different decision of solving problems might cause farmers receiving different levels of farm outcomes.

Finally, to see the impacts of management capability, this study evaluated farm outcomes by measuring efficiency. The findings based on using a data envelopment analysis revealed that it is crucial to increase technical, allocative and economic efficiencies on farms in this study area. Growing cassava in the early rainy season and harvesting it after 10-11 months could lead a farm achieving its full efficiency. To increase technical and allocative efficiencies, the results of a Tobit regression show that farmers with access to more than one irrigation system tended to have higher technical efficiency. Furthermore, a smaller farm size and larger number of family labor were positively associated with a higher allocative efficiency. However, there were no relationship between farmers' management capability and farm outcome in this study.

As previously stated, the findings of this study are conclusive proof that 1) farmers in Northeastern Thailand have an ineffective management capability with regard to managerial ability, ability to allocate farm resources, adopt new technologies and produce maximum farm outcomes, and make decision to deal with problems in the efficient way. Accordingly, all these characteristics of farmers' management capability are crucial to improve. 2) To improve farmers' abilities, the process of farmer-to-farmer learning is important to consider. As this process give famers easier access to agricultural information and new technologies. 3) To enhance farmers making decision effectively, farmers should be trained how to seek new alternatives, analyze the impacts and choose the best solutions for implementation.

タイにおける農家の経営能力の特徴に関する研究

博士論文摘要

農家の経営能力は農業経営における第 4 の農業投入であり，その他の投入である土地，労働力，資本の 3 つを管理するという重要な役割を担っている。先行研究では，農家の経営能力の向上は，経済状況の変化や気候変動の中で農業経営を発展させていく上での潜在的解決方法のうちの一つだとされている。農家の経営能力を向上させるためには，農家の経営能力の特徴について十分に理解する必要がある。しかし，先行研究においてタイ農家の経営能力に見られる特徴を明らかにするために，いくつかの手法が用いられてきたものの，その明確な定義はいまだに示されていない。また，先行研究では，農業生産や農家の生計を向上させる上で最適な方法を特定する際，収益性や効率性，農家の満足度などの農業の一部分のみの測定に焦点をあてており，経営能力については議論されてこなかった。以上のことから，タイにおける農家の経営能力の特徴を明らかにし，学術的に空白となっている部分を研究において扱うことは重要だと考えられる。そこで，本研究では，東北タイにおける家族経営農家を対象に，農家の経営能力に見られる特徴を，特に「個人特性」と「意思決定」という 2 つの側面に着目して明らかにすることを課題とした。さらに，農家の経営能力と農業生産の経営成果との関係を確認した。

本研究は，コンケン県内の 5 つの農村に居住する農家世帯の世帯主（もしくはその妻）に対して，2012 年 8 月から 2016 年 8 月の間に数回にわたって行われたインタビューに基づいている。対象農家は無作為に抽出されているが，最低でも 1 つの農業用ため池を保有していることを条件とし，また，農家間で土壌肥沃度に大きな差異がないことを考慮して選定した。

「個人特性」に関して，本研究では農家の能力と態度の 2 点に注目した。農家の能力のレベルは 9 技能から構成される管理能力に関する非認知的能力テストを利用して測定され

た。その結果，対象農家の間ではリスク指向性，資源の運用，意思決定，コミュニケーション能力，目標設定能力に対する理解度が高いことが示された。一方で情報収集能力や財務・会計管理能力，マーケティング能力に対する理解度は中程度にとどまっていた。農家の能力レベルに寄与する要因は，グループ活動への参加と農家の財務・会計管理能力，マーケティング能力，目標設定能力との間に有意な正の相関関係がみられ，さらに，世帯収入と情報収集能力，農家の年齢と意思決定能，保有する水田の面積と目標設定能力の間にも，強い正の相関が見られた。

次に，農家の経営管理および経営発展に対する態度について，経営効率性を基準にして効率的な農家と非効率的な農家に分類し，この二者の間で比較分析を行った。その結果，農業経営および経営発展に対する態度に関して，両者の間に大きな差異は見られなかった。どちらのタイプの農家であろうと，農業経営の成果により関心を抱いている者は，情報や意見の開示に積極的であり，財務上のリスクを負うことにも抵抗が少なく，農業に関わる活動にストレスを感じることなく，むしろ楽しみを見いだしていた。加えて，農家は自身の農業経営を発展させていくにあたって，農業生産の質の向上と生産コストの削減が最も重要な課題だと認識していることが明らかになった。

「意思決定」の側面に関して，まず，農家が農業に関する情報をソーシャル・ネットワークにおいて入手・共有する過程を明らかにし，農家が何らかの農業問題に直面した際に下す意思決定の過程を例証した。知識獲得に関する調査結果からは，対象農家は自らが所属する社会的ネットワークにおける農家同士の情報交換によって，農業に関する情報に容易にアクセスできていることが明らかになった。また，経営能力の高い農家は，地域コミュニティにおける情報交換の中心となっていることがわかった。これは，農業問題に関する相談をする際，農家は，外部の人間より同じ地域ネットワークに属している者のほうが相談しやすいこと，能力の高い農家は自身の知識や技術を他の農家と共有することを好んでいるからであることが示された。

次に，問題に直面した際の農家の「意思決定」に関する事例研究では，まず農業経営に

関わる諸問題を抽出した上で，その深刻度を評価し，次にそれぞれの問題に対して農家がどのような対応を行ったかを調査した。その結果，調査地において主要な農業問題は，深刻な干ばつであり, 次いで販売用農産物の価格低下が挙げられた。問題の解決に関しては，深刻な問題を抱えている農家の半数は，その問題に対する解決策を年次ごとに決めているため，同様の問題に再び直面する可能性が高い傾向がみられた。一方で深刻な問題を抱えていない農家は，問題の処理，ひいては克服のために，複数の解決策を探した上で，それらの効果を分析し最適な策を選定・実施していた。このことを，特に経営成果において効率性の高い 5 戸の農家を事例に例証し，意思決定の違いが農家間における経営成果の差をもたらしている点について考察を加えた。

最後に，経営能力の優劣が経営成果にもたらす差異をみるために，対象農家の効率性を測ることで，彼らの業績を評価した。包絡分析法（DEA）を用いた分析結果から，調査地の農家にとって技術的効率性，資源分配効率性，経済的効率性の向上が喫緊の課題であることが示された。雨季の初めにキャッサバの栽培を始め，10~11 ヶ月後にそれらを収穫することは，上述した 3 つの効率性すべての向上につながっていた。また，技術的効率性と資源分配効率性に関して，2 つ以上の灌漑設備へのアクセスが可能な農家は技術的効率性が高い傾向にあり，農場規模の小ささと家族労働力の大きさは資源分配効率に対して正の相関を示していた。しかし，この分析では、経営能力の優劣と経営効率性との明示的な関係は見出すことができなかった。

本研究に関わる一連の調査結果から以下の結論を得た。１）東北タイにおける対象農家は，管理能力，資産分配能力，新技術の導入と生産量の最大化，効率的に問題を解決するための意思決定に関して，十分な経営能力を持ち合わせていない。ゆえに，それらすべての経営能力の改善は重要な課題である。２）農家の経営能力向上を図るうえで，農家間での知識移転の過程は考慮に値する重要な要素であるといえる。３）農家の意思決定をより効率的なものにするためには，彼らに対し，どのように代替的な方法を見つけ出し，その影響を分析し，最適な選択肢を選ぶのかを教授する必要がある。

List of Publications

Major publication

1. Panatda Utaranakorn and Kumi Yasunobu (2015). Farm Managerial Competency Level of Farmers in Northeastern Thailand: A Case Study on Farmers in Khon Kaen Province. JAPANESE JOURNAL OF FARM MANAGEMENT, Vol. 52, No. 4, pp. 43−48

This article covers chapter 4.

2. Panatda Utaranakorn & Kumi Yasunobu (2016). Rice Farmers' Attitudes toward Farm Management in Northeastern Thailand. Journal of Agricultural Science, Vol. 8, No. 8, pp. 21−31 (DOI: 10.5539/jas.v8n8p21)

This article covers chapter 5.

3. Panatda Utaranakorn and Kumi Yasunobu (2017). The mutual influence of managerial ability and social networks of farmers on participation in an organic vegetable group in Khon Kaen province, Thailand. Kasetsart Journal of Social Sciences, Volume 37, Number 3, Page 127−131 (DOI:10.1016/j.kjss.2016.08.001)

This article covers chapter 6.

4. Panatda Utaranakorn and Kumi Yasunobu (2016). Technical, Allocative and Economic Efficiencies of Family Farming in Northeastern Thailand: Data Envelopment Analysis (DEA) Approach. JAPANESE JOURNAL OF FARM MANAGEMENT, Vol. 54, No. 3, pp. 115−120

This article covers chapter 8.