THESIS APPROVAL

GRADUATE SCHOOL, KASETSART UNIVERSITY

Master of Science (Agricultural and Resource Economics)

DEGREE

Agricultural and Resource Economics — **FIELD**

Agricultural and Resource Economics — **DEPARTMENT**

TITLE: Adoption of Aromatic Rice in Mekong Delta, Vietnam

NAME: Ms. Tran Hoai Thao Trang

THIS THESIS HAS BEEN ACCEPTED BY

(Assistant Professor Orachos Napasintuwong Artachinda, Ph.D.) **THESIS ADVISOR**

(Mr. Santi Sanglestsawai, Ph.D.) **THESIS CO-ADVISOR**

(Associate Professor Nguyen Tri Khiem, Ph.D.) **THESIS CO-ADVISOR**

(Mr. Decharut Sukkumnoed, Ph.D.) **DEPARTMENT HEAD**

APPROVED BY THE GRADUATE SCHOOL ON _____

(Associate Professor Gunjana Theeragool, D.Agr.) **DEAN**

THESIS

ADOPTION OF AROMATIC RICE IN MEKONG DELTA, VIETNAM

TRAN HOAI THAO TRANG

A Thesis Submitted in Partial Fulfillment of
the Requirements for the Degree of
Master of Science (Agricultural and Resource Economics)
Graduate School, Kasetsart University
2014

Tran Hoai Thao Trang 2014: Adoption of Aromatic Rice in Mekong Delta, Vietnam. Master of Science (Agricultural and Resource Economics), Major Field: Agricultural and Resource Economics, Department of Agricultural and Resource Economics. Thesis Advisor: Assistant Professor
Orachos Napasintuwong Artachinda, Ph.D. 79 pages.

Vietnam is the one of three largest rice exporters, accounting for 22.71% of world's total rice export in 2013. Nevertheless, the majority of exported rice is of low to medium quality. While rice consumption throughout Asia is experiencing a downward trend, particularly among higher income countries, aromatic rice (AR) is still highly demanded. The increase of high quality rice area and reduction of low quality rice area will not only increase farmers' income but also improve quality for Vietnamese rice exports. This study investigates factors contributing to aromatic adoption based on Random Utility Theory. In addition, Contingent Valuation Method is used to estimate price premium for aromatic rice adoption in Mekong Delta (MD) – the main rice area of Vietnam.

The result from binomial logit model reveals that not only communication with extension officers and knowledge transfer from attending field demonstration but also connection with private companies through contracts and access to seeds are positively related to aromatic rice adoption. Furthermore, the probability of willingness to switch to AR production among LQR growers increases with the increase of market price difference between LQR and AR. The mean of their willingness-to-accept price difference between AR and LQR is estimated at 1,085 VND/kg, which is higher than the current price difference of 731 VND/kg. The findings of this study suggest that in addition to the increasing on-farm demonstrations and strengthening the linkage between farmers and private companies, a sufficient increase in market price premium for AR could be one of the ways to create more incentive for AR adoption and reduce LQR area in MD.

_____ _____ ___ / ___ / ___

Student's signature Thesis Advisor's signature

ACKNOWLEDGEMENTS

First of all, I would like to express my deep grateful to my two sponsors: the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) and the Center of Advanced Studies for Agriculture and Food (CASAF), KU Institute for Advanced Studies, Kasetsart University. This study is fully supported by these sponsors.

I am very grateful to have had the opportunity to work with my advisor, Assistant Professor Orachos Napasintuwong Artachinda. Working with her taught me to be a professional economist and to be a methodical researcher. I could not say thank you enough for her guidance, criticism, encouragement and inspiration during my time of working on my study. I also thank her for her patience, caring and support for me during my difficult time in studying abroad. I am especially grateful to Associate Professor Nguyen Tri Khiem, my thesis co-advisor, for his recommendations and tremendous support in the challenging time of doing surveys in the Mekong Delta. My gratitude also goes to my second thesis co-advisor Dr.Santi Sanglestsawai, who contributed significantly to the quality of my study. I also would like to express my thanks to my committee member Associate Professor Dr. Suwanna Praneetvatakul for her useful recommendations and beneficial feedback about my research.

My greatest gratitude goes to my beloved parents, Dr. Tran Van Khoi and Ms. Hoai Thi Thuy, who are always besides me despite the distance and give me a lot of encouragement during my graduate study. Without their love, care, and belief, I could not have accomplished this goal and come this far.

Tran Hoai Thao Trang

November, 2014

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

Page

LIST OF TABLES

LIST OF TABLES (CONTINUED)

LIST OF FIGURES

LIST OF ABBREVIATIONS

AR	=	Aromatic rice
ARV	=	Aromatic rice varieties
CV	=	Contingent Valuation
CVM	=	Contingent Valuation Method
IASVN	=	Institute of Agricultural Science for Southeast Vietnam
FAO	=	Food and Agriculture Organization
IRRI	=	International Rice Research Institute
HQ	=	High quality
LQR	=	Low quality rice
MARD	=	Vietnamese Ministry of Agriculture and Rural Development
MD	=	Mekong Delta
RUT	=	Random Utility Theory
USDA	=	United State Department of Agriculture
CLRRI	=	Cuu Long Rice Research Institute
VAAS	=	Vietnam Academy of Agricultural and Science
DARD ST	=	Department of Agricultural and Rural Development Soc Trang

CHAPTER I

INTRODUCTION

This chapter contains the statement of problem, objectives, expected benefits and scope of the study. The outline of this study is described in the last section of this chapter.

Statement of Problem

Rice is a staple food for over half of the world's population (Food and Agricultural Organization of United Nations, 2004). Rice accounts for over 20% of global calorie intake, and it is not only staple food of 2.7 billion people but also the way of life of more than half the world's farmers.

Over 90% of the world's rice is produced and consumed in six Asian countries: China, India, Indonesia, Bangladesh, Vietnam and Japan, comprising 80% of the world's production and consumption(Abdullah *et al.*, 2006). However, recently the production of export from Asian countries has been increasing but the consumption has been decreasing(Bruinsma, 2003). With growing prosperity and urbanization, per capita rice consumption has started to decline in the middle- and high-income Asian countries such as Japan, Taiwan and the Republic of Korea (Abdullah *et al.*, 2006). As income grows, customers tend to substitute rice with higher quality food containing more protein and vitamins such as processed rice, healthy rice, vegetables, bread, fish and meat. Japan and Republic of Korea have already made this transition, and the rest of Asia will be making it in proportion to the pace of their economic growth (Papademetriou, 2000). The decreasing rice consumption in Asia will result in the oversupply of rice that would suppress world market prices, ceteris paribus. Importing countries may enjoy cheaper prices but rice producing countries could suffer, and the poverty in Asian rural areas might increase (Abdullah *et al.*, 2006). Therefore, with the current trend of global rice consumption,

rice exporting countries may focus on rice quality rather than quantity as alternative for exports. Furthermore, the improvement in rice quality worldwide is necessary to meet the growing global demand for high quality rice (Fitzgerald *et al.*, 2009).

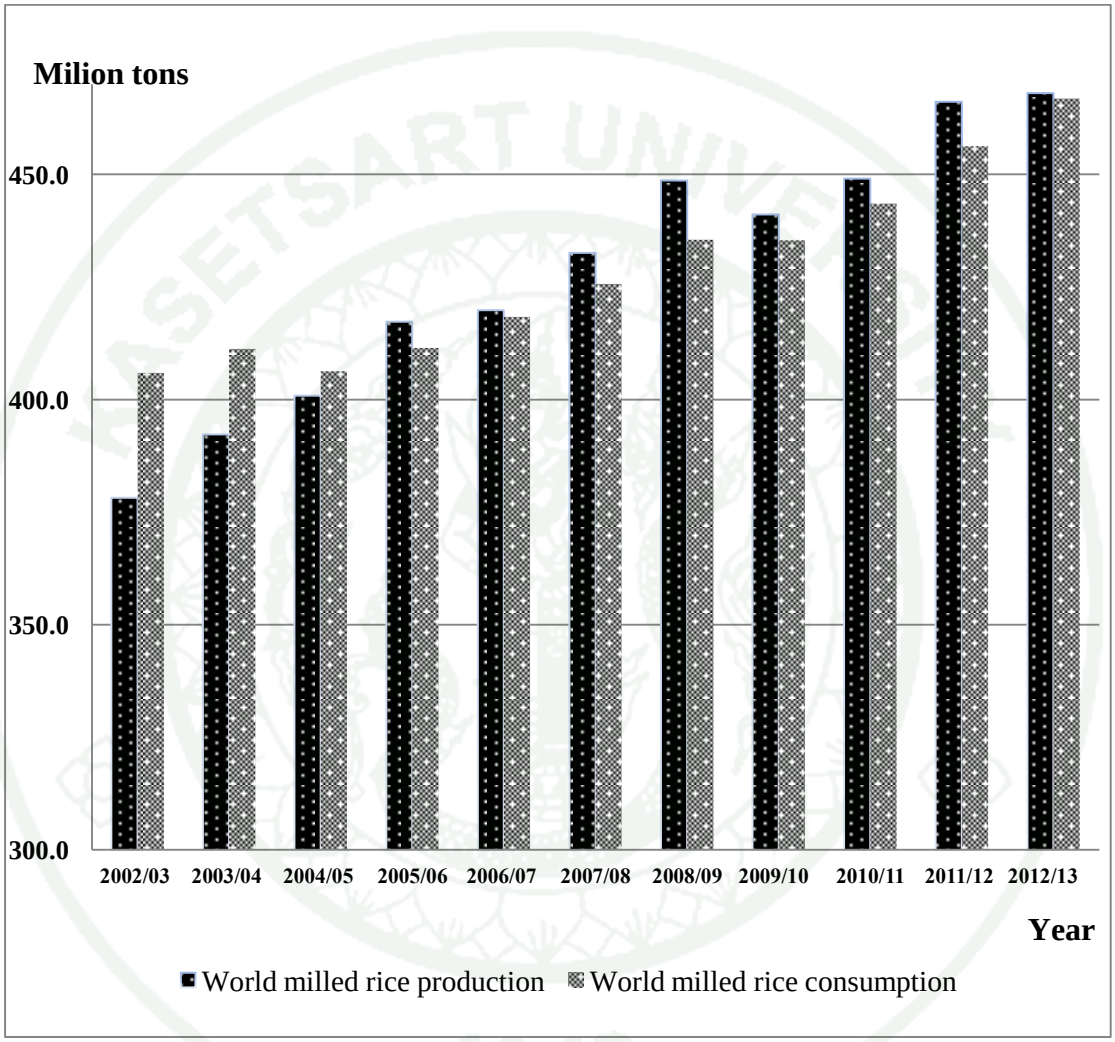

Figure 1.1 World milled rice supply and consumption

In Vietnam, rice is the most important crop that is consumed by about 70% of the population and is the main source of farm income contributing to about 67% of total household income (Tuong, 2010). During the last three decades, Vietnam has achieved a remarkable increase in paddy rice production, which not only suffices to feed the country's population and greatly contributes to price stability, but also makes Vietnam the second largest rice exporting country since 2005. Each year about six to

seven million tons of rice is exported from Vietnam accounting for 24.6 % total rice export in the world; in 2012, Vietnam became the second biggest rice exporting country with 7.72 million tons of exports (Vietnam Ministry of Agriculture and Rural Development, 2012). Nevertheless, despite the large volume of rice exports, the export price of Vietnamese rice is relatively low compared to other exporters. The price difference between Vietnam's and Thailand's rice maintains high at around 200 USD/ton for the same grade. Along with low price, since the beginning of the 1990s, rice production costs started to rise and rice farmers have been facing declining profits as a result of changes in market factors such as decreasing rice price, increasing input price and rapid withdrawal of labor from agricultural sector (Papademetriou, 2000).

Table 1.1 Different rice price of exporting countries from 2008 to 2012

(Unit: USD/tons)

Year	Thai parboiled 100%	Thai fragrant	Thai 5%	Viet 5%	Thai 25%	Viet 25%
2008	722	914	682	614	603	553
2009	619	954	555	432	460	384
2010	532	1045	492	416	444	387
2011	563	1054	549	505	511	467
2012	594	1091	573	432	560	397
2013	530	1180	518	391	504	363

Source: FAO (2014)

Aromatic rice constitutes a small but an important group of rice (Singh *et al.,* 2000). This rice is estimated to account for 15-18% of the rice trade. Recently volatility in agricultural commodity prices has affected the trade in world rice market, but aromatic rice prices have not had much impact. The fragrant rice reached its highest price in the spring of 2008 during world food price crisis, and has remained the highest price among other rice sectors (Giraud, 2013). In Vietnam, domestic consumers prefer aromatic rice; thus it commands high price in the market. The price of aromatic rice is always relatively higher than non-aromatic rice in Vietnam. Tuong (2010) found that farmers who cultivate aromatic rice make larger profits compared

with those cultivating non-aromatic rice. In recent years, Vietnamese aromatic rice has been increased in exports and market share, but the exporting quantity and the price of Vietnamese aromatic rice is relatively lower than others exporters such as India, Pakistan and Thailand. In 2010, Basmati rice exports from India and Pakistan were estimated at 1.8 million tons and 1.05 million tons, respectively. Thailand exported 2.65 million tons of Jasmine rice while Vietnam exported only 0.24 million tons of aromatic rice (Giraud, 2013). In Asia, Vietnam and Cambodia garner 20 to 35% of fragrant rice market in Hong-Kong and Singapore, but receive very low prices compared to Thai Jasmine rice (Giraud, 2013). Since aromatic rice procures the highest prices on trade market, its authentication is still an important topic. However in the recent years, while the demand for fragrant rice increases slightly, production does not always follow this trend (Giraud, 2013).

The Mekong Delta is one of seven important regions in the system agricultural economy areas of Vietnam, and almost all rice exports from Vietnam are produced in this area. It is located in the South of Vietnam, on the northern border with Cambodia, on the southern border with the China Sea, and on the western border with Thailand. In economic geography, the Mekong Delta is located in the area of advantageous transportation, both maritime and air, between South Asia, East Asia as well as Australia and other islands in the Pacific; this is the important position in international exchanges. The natural area of the Mekong Delta is approximately four million hectares, accounting for about 12% of the total area of the country. This accounts for 27.4% of agricultural land, arable land accounts for 45.8% of rice, fruit land accounts for 36.4%, and aquaculture land occupies 71.6% (of which shrimp accounted for 91.8%) of the country. Rice production in the Mekong Delta accounts for over 50% of total annual rice output of Vietnam; it contributes to 90% and 94% of total rice exports in quantity and value, respectively (Hai, 2012). With its important role, the change in rice production in the Mekong Delta directly affects the rice exports of Vietnam.

Aside from aromatic rice, there is significant area of low quality rice variety in Mekong Delta named IR50404 rice variety. This is short hard grain rice variety which

is normally used to produce 25% broken rice for rice exports of Vietnam. However, recently, some rice exporters such as India, Thailand, and Pakistan are increasing quantity as well as quality of their rice export, making low quality rice of Viet Nam is difficult to find in the export market. Despite the Vietnamese Ministry of Agriculture and Rural Development's (MARD) efforts to discourage the use of low quality rice variety IR 50404, it is still preferred by farmers because of its high yield, ease of growth and lower requirements for investment when compared to other high quality varieties.

With the aim of increasing income for farmers, MARD is encouraging farmers to produce high quality rice such as aromatic or specialty rice and produce less low quality rice such as IR 50404. However, currently, the growth rate of aromatic rice area is still low with 2.28% per year) (Tuong, 2010) and the area of IR 50404 is relatively high at more than 30% total rice area in Mekong Delta (MARD, 2011). Since technological change can directly affect output, product quality, profit, financial performance for farmers; the adoption of new technologies offers economic opportunities and challenges to farm businesses in local area. However, there has been no study targeted at the problem of low adoption of aromatic rice in neither Vietnam nor Mekong Delta area. Therefore, this study looks to find the determining factors affecting the adoption of aromatic rice in the Mekong Delta; these determinants are essential, not only for the public and private sectors to promote aromatic rice production, but also to help meet the increasing demands in the world market and improve income for Vietnamese rice producers.

Objectives of the Study

1. To investigate the factors that influence the probability of adopting aromatic rice in the Mekong Delta.

2. To estimate the change of probability to adopt aromatic rice at different hypothetical prices difference.

Scope of the Study

In the first objective, the research investigates factors that influence farmers' adoption of aromatic rice in the Mekong Delta, Vietnam. The information was gathered from farmers who cultivated rice in cropping seasons 2012-2013. In the second objective, the research estimates the willingness to accept growing aromatic rice amongst aromatic rice non-adopters. The estimation was based on information of farmers who cultivated low quality rice variety IR 50404 in Winter-Spring season in 2013.

Definition of Terms Used in the Study

Aromatic rice is one of major types of rice. It is known for its grain aroma which caused by the chemical compound 2-acetyl-1-pyrolline (Pachauri *et al.*, 2010). According to Vietnam standard about rice term and definition TCVN 5644, aromatic rice is defined as rice with a specific flavor (TCVN, 1999). In Vietnam, aromatic rice varieties include imported varieties such as Jasmine 85, Khao Dawk Mali, and local aromatic rice varieties such as ST 5, Nang Huong, Tau Huong (MARD, 2011).

High quality rice in Vietnam is defined as soft and long grain rice varieties which are used to produce 5% to 15% broken rice. There are some main characteristics of high quality rice such as the amylose is from 3% to 25%, the length of grain is more than 7mm (MARD, 2010). Standards of 5% to 15% broken rice is in appendix A2.

Low quality rice in Vietnam is defined as short and hard grain rice varieties which are used to produce 25% broken rice (MARD, 2010).

CHAPTER II

LITERATURE REVIEW

This chapter is divided into two parts. The first part is a review of the theoretical concepts that are relevant to adoption and willingness to accept, and the second part summarizes the literature which is related to the adoption of new technology in agriculture.

Theoretical Framework

Technology Adoption

Technology innovation is considered as an idea, practices or project that is perceived as new by individual or group of people (Rogers, 2003). An innovation can be not only tangible such as new types of medicine, seed varieties, but also can be tangible such as physical design methodology or pedagogical technique. The notion of an innovation's newness can be relative to both place and population. An innovation is not always a new invention; an innovation could have been invented a long time ago. If individuals perceive it as new, then it can still be an innovation for them (Diagne, 2006).

Adoption is a decision of "full use of an innovation as the best course of action available", and rejection is a decision "not to adopt an innovation". Studies about adoption emphasize factors and effects on individual decisions of starting to use an innovation (Rogers, 2003). Scholars also define adoption as the degree to which a new technology is used in long-run equilibrium when farmers have complete information about the technology and its potential.

The role of adoption studies is to answer the question of how to promote new technology for farmers or extension institutions, with the aim of improving the

efficiency of technology generation or research and extension efforts. Because policy makers lack understanding about the real adoption process in areas where they want to increase the adoption rate, research or extension efforts often fall short of their goals. Adoption studies may point out factors that have been limited adoption rate. Besides, adoption studies may show the potential for technology diffusion by demonstrating progress in high adoption areas, or they may analyze the problems in areas where the speed of adoption has been slow.

Theoretical framework of technology adoption

Based on Random Utility Theory (RUT), an individual makes their decision of adopting technology if it maximizes their perceived utility (Fernandez-Cornejo *et al.*, 1994). However, researchers cannot observe individual's utility to predict his choice to adopt or not adopt, but some attributes of alternatives as faced by the decision makers and some attributes of the decision makers, labeled X_i (Train, 2003). RUT presumes that the utility of taking action of adopting (U_A) is composed of a deterministic component (V_A), which can be calculated based on observed characteristics, and a stochastic error component (ε_A), which is unobserved so that:

$$\mathrm{U_A} = \mathrm{V_A} + \varepsilon_\mathrm{A}. \qquad (1)$$

Where V_A is representative utility function of adopters specified through observable attributes of alternatives and observable attributes of adopters, labeled ($\mathrm{X_A}$), and ε_A captures the factors that affect utility but are not included in the model. Similarly, V_{NA} is representative utility function of non-adopters.

$$\mathrm{V_A} = \alpha_\mathrm{A}\mathrm{X_A} + \varepsilon_\mathrm{A} \qquad (2)$$

$$\mathrm{V_{NA}} = \alpha_{\mathrm{NA}}\mathrm{X_{NA}} + \varepsilon_{\mathrm{NA}}$$

$$\mathrm{V_A} - \mathrm{V_{NA}} = \alpha_\mathrm{A}\mathrm{X_A} - \alpha_{\mathrm{NA}}\mathrm{X_{NA}} + \varepsilon_\mathrm{A} - \varepsilon_{\mathrm{NA}} = \beta_\mathrm{i}\mathrm{X_i} + \varepsilon_\mathrm{i} \qquad (3)$$

The adoption of a technology can be modeled as a choice between two alternatives: adopt or not adopt technology. In the adoption study, the use of technology by farmers can be observed. Therefore, in most empirical studies, the observed decision to use technology is viewed as the outcome of binary choice model. Hence, a farmer j's choice can be represented by a dependent dummy variable:

$$Y_j = \begin{cases} 1 \text{ if adopt} \\ 0 \text{ if not adopt} \end{cases} \quad j = 1, 2, \ldots n \tag{4}$$

The probability that a farmer adopts the technology is denoted as:

$$P_A = P[Y_j = 1] \tag{5}$$

$$P_{NA} = 1 - P_A$$

An individual chooses to adopt aromatic rice varieties (ARV) if utility of adopting is greater than the utility of not adopting so equation (5) becomes

$$P_A = \text{Prob}\,(U_A > U_{NA})$$

$$= \text{Prob}\,(V_A + \varepsilon_A > V_{NA} + \varepsilon_{NA})$$

$$= \text{Prob}(\varepsilon_{NA} - \varepsilon_A < V_A - V_{NA})$$

$$= \int_{\varepsilon}^{\infty} I\,(\varepsilon_{NA} - \varepsilon_A < V_A - V_{NA}) f(\varepsilon_n) d\varepsilon_n$$

$$= \int_{\varepsilon}^{\infty} I\,(\varepsilon_i < \beta_i X_i) f(\varepsilon_n) d\varepsilon_n \tag{6}$$

Where I(.) is the indicator function, equaling 1 when the expression in parentheses is true and 0 otherwise. This is a multidimensional integral over the density of the unobserved portion of utility, $f(\varepsilon_n)$.The different choices are derived

under different specifications of the density of unobserved factors, $f(\varepsilon_n)$. Both probit and logit can be used for discrete choice model. However, comparing to logit model, one limitation of probit model is that they require standard normal distributions for all unobserved components of utility, $f(\varepsilon_n)$ (Train, 2003). Since the standard normal distribution has density on both size of zero, meaning that unobserved variables can be both positive and negative. However, in this study, farmer's willingness to accept the price difference and the price difference between aromatic rice and normal rice are considered as unobserved factors, and it is presumed to be greater than zero. Therefore, the use of a distribution that has density only one side of zero is more appropriate. Besides, logit model has some advantages (Train, 2003) such as consistent with utility maximization, the formula for choice probability takes close form and it is readily interpretable. The researcher can choose to use logit when she knows unobserved factors are uncorrelated over alternatives (Train, 2003). Since alternatives in this study are two different types of varieties and have fairly different characteristics such as soil suitability and risk in growing, this critical assumption of logit model is more appropriate. Thus, logit model is chosen for this study. The logit model is obtained by assuming that the stochastic components ε_i are independent and identically distributed with a Weibull distribution (Maddala and Lahiri, 1992) so that the equation (6) becomes

$$P_A = P(Y_j = 1) = \frac{e^{\beta_i X_i}}{(1 + e^{\beta_i X_i})} \quad (7)$$

Where X_i is vector of explanatory variables and β_i is intercept parameters.

The probability of not adopting ARV (Y_j =0) is

$$P_{NA} = 1 - P_A = \frac{1}{(1 + e^{\beta_i X_i})}$$

$$\frac{P_A}{P_{NA}} = e^{\beta_i X_i} \quad (8)$$

$$\mathrm{Ln}\left(\frac{\mathrm{P_A}}{\mathrm{P_{NA}}}\right) = \beta_i \mathrm{X_i} \qquad i = 1, 2, \ldots \ldots \mathrm{n} \qquad (9)$$

β_i is coefficient or influence of factors on $\frac{\mathrm{P_A}}{\mathrm{P_{NA}}}$; X_i is factors influenced adoption.

To estimate the probability of individual's choice to adopt or not adopt a technology, equation (7) is used. The marginal effect of factor X_i indicates the influence of factor X_i on the probability of adoption is defined as follows:

$$\left.\frac{\Delta \mathrm{P_A}}{\Delta \mathrm{X_i}}\right|_{\text{all other x constant}} = \frac{\partial \mathrm{P_A}}{\partial \mathrm{X_i}} = \beta_i \mathrm{P_A P_{NA}} \qquad (10)$$

Theoretical framework for analyzing dichotomous contingent valuation responses and evaluate farmers' willingness to accept (WTA)

The basic model for analyzing dichotomous contingent valuation (CV) responses is the random utility model. In the CV case, there are two choices or alternatives. However, deterministic part of utility include vector of farmer *j* characteristics, attributes of choice (z_j) and farmer j's discretionary income (y_j)(Haab and McConnell, 2002). Therefore, the utility function for respondent *j* in state *i* of the change to be valued (*i* = 0 being the base state and *i* = 1 being the final state) can be written as:

$$\mathrm{U_{ij}} = \mathrm{U_i}(\mathrm{y_j}, \mathrm{z_j}) \qquad (11)$$

The indirect utility function is defined as

$$\mathrm{V_{ij}} = \alpha_i \mathrm{z_j} + \beta_i \mathrm{y_j} \qquad (12)$$

Where α_i denotes an m-dimensional vector of parameters, z_j is an m-dimensional vector of characteristics of the individual, including the characteristics of the given CV scenario. y_j is the respondent's discretionary income, and β_i is marginal

utility of income. t_j is the bid vector (or monetary addition) for CV scenario, so the deterministic utility for the base state (i = 0 = Not Adopt (NA)) and final state (i = 1 = Adopt (A)) is:

$$V_{NAj} = \alpha_{NA} z_j + \beta_{NA} y_j$$

$$V_{Aj} = \alpha_A z_j + \beta_A (y_j + t_j)$$

Assuming that the marginal utility of income is constant so $\beta_A = \beta_{NA;}$ thus, the change in deterministic utility for respondent *j* can be written as:

$$V_{Aj} - V_{NAj} = (\alpha_A - \alpha_{NA}) z_j + \beta_A (y_j + t_j) - \beta_{NA} y_j$$

$$= \alpha z_j + \beta t_j \quad (13)$$

In general, willingness to accept (WTA) is the amount of money that makes respondents indifferent between status quo (not adopt) and the proposed CV scenario (adopt). Thus:

$$V_{Aj} - V_{NAj} = (\alpha z_j + \beta t_j) = 0 \quad (14)$$

$$E(t_j) = E(WTA \mid \alpha, \beta, z_j) = -\frac{\alpha z_j}{\beta}. \quad (15)$$

Where *E* is the expectation of farmer's WTA a new technology. Using the binominal logit model, the probability of farmer's willingness to adopt is as followed:

$$P_A = \frac{e^{\alpha z_j + \beta t_j}}{(1 + e^{\alpha z_j + \beta t_j})}. \quad (16)$$

Review of Related Studies

Studies about crop varieties adoption

There were numerous technology adoption studies conducted over the last 50 years, and these previous studies measured adoption through long-term rate of adoption. Feder*et al.,* (1985) is a very first study reviewed the literature on adoption and diffusion of agricultural innovation. He concluded that in adoption studies, the most important factors that determine adoption decision includes farm size, risk and uncertainty, human capital and labor availability. In general, the use of time series evidence to evaluate percentage of farmers employing the new technology at each date began with Griliches (1957) and Rogers and Cartano (1962), who studied the factors responsible for the cross sectional differences in past and current rates of use of hybrid seed corn in United States. The aim of this kind of study is to capture the shape of the time series diffusion process, and these studies tend to model the pattern of adoption as a logistic-shaped function over time.

Later, adoption was examined mainly for understanding factors causing adoption rates to differ and constrains of the speed of agricultural innovation adoption. However previously, most of studies focused toward technologies that increase productivity (Caswell and Zilberman, 1985; Rahm and Huffman, 1984). Since the 1980s, adoption studies have shifted their focus to adoption of agricultural technologies that affect the environment or farming practice (Alonge and Martin, 1995; Drost *et al.*, 1998; Kim *et al.*, 2005; Paudel *et al.*, 2005). There were not many studies on technology innovation that affects product quality.

Recently, studies about technology adoption among agricultural producers have received tremendous attention among agricultural development planners. These studies have generally focused on either technology adoption process at farm level or on identifying the significant characteristics associated with adopters of individual technology. However, it is considered to be more beneficial to focus on the latter

with the principal aim of targeting specific variables for policy formulation or specific group of farmers to promote the adoption of an innovation (Saka and Lawal, 2009).

There are a numerous studies that investigate factors affecting adoption of various agricultural technologies (Beltran *et al.*, 2013; Noorhosseini-Niyaki and Allahyari, 2012; Saka and Lawal, 2009). In terms of rice production, one of the first studies of modern varieties adoption in Asia is a 1965 survey of 270 farmers in two villages of South Kanara district, Mysore, India, in which diffusion curves were plotted for rice improved seeds. Later studies focused more about factors affecting adoption of high yield or improved rice varieties (Mariano *et al.*, 2012; Wang *et al.*, 2012).

Based on profitability of the technology and risk management strategies, factors influencing adoption of new agricultural innovation can be divided into four major categories: (i) farm and farmers' characteristics, (ii) characteristics of the technology and variables related to technology (Fernandez-Cornejo et al., 1994), (iii) external factors such as infrastructure, credit and extension (Gerhart, 1974; Kaliba et al., 2000). The following review defines the factors influencing the adoption of aromatic, modern and improved rice and new crop varieties from previous studies.

Factors influencing the adoption of modern, improved and high quality varieties

Based on previous studies, the factors that influence the adoption of new crop varieties can be divided into three groups. Those are farm characteristic, farmers' characteristics and external factors that related to improve varieties. The relationship of the explanatory variables to technology adoption is based on theory and from previous empirical results as follows:

Farm characteristics

Farm size is one of the most important factors that the empirical adoption studies focused on since it is considered as farmer's resource or capital. It is proved that resource-poor farmers are often reluctant to invest in any untried input due

mainly to their limited cash resources or access credit (Langyintuo and Mungoma, 2008). Considering risk in agriculture technology, it is indicated that relatively wealthier households have a better ability to cope with production and price risks and consequently more willing to adopt new technologies than their poorer counterparts (Hardaker *et al*., 1997). This conclusion is also supported by some studies about improved rice varieties adoption such as Mariano *et al.* (2012), who found that, in the Philippines, farmers who own large areas of land can spread the risk of technology failure by allocating only a portion of their land to modern rice varieties. Therefore, they are likely to adopt modern rice varieties. Several studies also found positive relationships between farm size and adoption of high yield varieties (HYV) and improved rice varieties (Asrat *et al.*, 2010; Langyintuo and Mekuria, 2008; Mariano *et al.*, 2012; Saka and Lawal, 2009; Wang *et al*., 2012). However, a study about technology adoption in farming system in Can Tho province, Mekong Delta, Vietnam by Truong and Yamada (2002) found that large land-holding farmers feel that they don't want to adopt new technologies. They reasoned that, if the yield loss due to new technologies were in large fields, the amount of loss would be greater.

Soil characteristics are proved to be another relevant factor in technology adoption. The appropriateness of rice varieties under the major soil condition of a given area was also observed to be an important physical factor affecting the use of new rice varieties by David and Otsuka (1994) and Otsuka and Yamano (2006). Rodriguez and Nga (2012) also concluded that planting rice in a good soil that suitable with rice varieties increases rice yield to 750 kg/ha in the Red River Delta of Vietnam, so those who have good soil for growing aromatic rice varieties are expected to have greater adoption rate. This factor is often accounted by obtaining observations from different soil quality areas and using location specific dummy variables to group local terms for variation in soil or land type.

Farmers' characteristics

Age is one of the most common influential factors on adoption of new rice varieties. In most adoption studies in low-income countries, age of farmers is often

used to reflect their experience. Farmers' age can generate confidence in reducing the risk of applying new varieties. Most previous studies have found a negative relationship between age and preference or adoption (Asante *et al.*, 2013; Daberkow and McBride, 2003; Gockowski and Ndoumbé, 2004). Asante *et al.* (2013) found that farmers who are less than 35 years old have a stronger preference for improved rice varieties than older one. Rodriguez and Nga (2012) also found that Vietnamese farmers in the Red River delta tend to increase the rate of adoption when they have more years of farming experience. Years of farming experience were found to be influential factor of new variety in Li *et al.* (2010)'s study. The result indicated that the higher year of farming experience farmers have, the more reluctant they are to adjust to new cultivation practice.

Education level has proved to be the human endowment factor that enables potential adopters to understand and evaluate new information, thus affecting both adoption and diffusion of new technologies (Huffman, 2004; Rahm and Huffman, 1984; Schultz, 1975). A person with high education is expected to have adequate knowledge on the importance of planting improved varieties. Exposure to education is assumed to increase the ability of farmers to obtain process, join in training courses, and use information relevant to the adoption of improved rice varieties.

Household size or the size of the family is one of the factors that have been included in adoption studies (Sain and Martínez, 1999). This variable is measured by the number of family members living in the household. This factor was found to have negative effects on the adoption of new varieties. This hypothesis is based on the assumption that larger families use greater proportion of their total revenue to satisfy their family consumption; thus, they might have greater budgetary constraint. However, with some labor intensive technology, this factor was found to positively influence technology adoption. He et al. (2007) found that the larger the household size is, the greater availability of labor for the harvesting and supplementary irrigation works. Thus farm size has a positive relationship with the adoption of irrigation technology as it requires great labor force available.

Perceptions of farmers about technology have been explored in previous adoption studies, and proven influencing probability of farmers' adoption of new varieties. Based on perceptions, farmers decide whether to adopt the varieties that increase their benefit or resolve their problem of low income or suitability with their soil characteristics. Chi and Yamada (2002) indicated that farmers in the Mekong Delta are willing to apply technology that gives them an increase in benefits.

External factors

Being a member of group is one factor that helps farmer in social learning which greatly influences their decisions to adopt innovative technologies. This is often seen when farmers in his or her group could observe others experimenting with the innovative technologies (Rogers, 2003).

Extension services such as on-farm demonstrations of new rice varieties and rice production training sessions encourage adoption because the exposure to information reduces subjective uncertainty about the technology (Asante et al., 2013; Ekasingh and Letcher, 2008). Those who have a good access to training courses are more likely to adopt the new technology. The access to extension services of farmers can be evaluated by the amount of contact time farmers have with extension agents or joining in the training course of new rice varieties production.

Information is an essential factor for farmer's adoption; for those who adopt a technology, they must first know about it. In addition to this, information about market demand is likely to affect farmers' decisions to choose crop varieties since market demand directly affects potential market price of product. The information can come from several resources. In order to examine the influence of types of information, previous studies commonly use existing extension programs and other media for providing information to farmers such as demonstrations in the area frequently of information accesses through radio, television, newspapers or magazines.

CHAPTER III

AROMATIC RICE IN MEKONG DELTA

Aromatic Rice Varieties in the Mekong Delta

In Vietnam, most import aromatic rice varieties come from the International Rice Research Institute (IRRI) and countries such as Thailand and Taiwan. Imported rice varieties play an important role in rice production, accounting for 980,000 hectare, accounting for 27.49% of the total rice area in the Mekong Delta (MARD, 2011). Recently, regions growing imported rice varieties such as IR 50404, Jasmine 85 and VN20 in the Mekong Delta have been growing. Besides imported aromatic rice varieties, the Mekong Delta also has some local aromatic rice varieties such as Nang Thom Cho Dao, Tai Nguyen and Thom Lai. However, these domestic aromatic rice varieties only shows their aroma in specific and small areas, mostly in Can Duoc district of Long An province. The aroma of some varieties is very specific to certain areas. For example, Nang Thom Cho Dao only shows its aroma in Can Duoc, Long an (Mekong Delta) However, some aromatic rice varieties such as Jasmine 85 or glutinous rice such as Nep Hoa Vang can maintain its slight aroma everywhere (Singh and Khush, 2000).

Imported aromatic rice varieties, such as Khao Dawk Mali 105 (from Thailand) and Basmati 370 (from India) were introduced to Vietnam in the 1980's and were tested in different sites in the Mekong Delta. Unfortunately, Basmati could not maintain its fragrance and produced very low yield. Khao Dawk Mali 105 was also tested and introduced in large areas of the Mekong Delta and reached the maximum cultivated areas of 5,000 hectares in 1992; then, the area reduced approximately to 2,000-3,000 hectares (Singh and Khush, 2000).

Currently, one of the most popular variety in the Mekong Delta is Jasmine 85, which is imported variety. Jasmine 85 was initially bred by IRRI from combinations of Pata/TN1/Khao Dawk Mali. The next generation was selected by American

scientists and was named IR 841-85. This variety came to Vietnam in 1992 with the trade name “Jasmine 85”. It is grown widely accounting for more than 20% rice area in the Mekong Delta (MARD, 2011).

Another popular variety is ST5, a new domestic aromatic rice variety. This variety was bred by a local person named Ho Quang Cua – Deputy of Department of Agriculture and Rural Development in Soc Trang province. It was being considered as a potential variety for coastal provinces in the Mekong Delta, especially in Soc Trang province since it is suitable with salinity intrusion. Its high value comes from its fragrance in both the raw and cooked rice and long-shaped form of the grains. The exporting price of this aromatic rice is 50% higher than average exporting rice price, and the growing area of this variety is 17,000 hectares, accounting for 10.3% total rice area in Mekong Delta in 2011 (MARD, 2011).

Rice Research Centers and Its Current Varieties Development in Mekong Delta

Rice research centers in Vietnam were established in 1975. Some institutes and universities have cooperated with IRRI to study and develop new rice varieties suitable to the Mekong Delta (MARD, 2011). Can Tho University and the Institute of Agricultural Science for Southeast Vietnam (IASVN) were the two principal institutes to participate in this development.

Cuu Long Rice Research Institute (CLRRI) was established in 1977 in O Mon district, Can Tho province. This public institution develops new rice varieties to supply rice farmers, mostly in the Mekong Delta. Currently, 53% of rice varieties in Vietnam and more than 80% of rice varieties in the Mekong Delta come from this institute (MARD, 2011).

Nowadays, with exotic germplasm, CLRRI has bred many high quality rice varieties every year; these varieties' names start with the letters OM, referring to the location of the institute in Omon district, Can Tho province of Mekong Delta. However, this institute has not succeeded to release new lines with aromatic trait.

Most aromatic rice varieties were developed based on exotic germplasm such as Jasmine 85 and Khao Dawk Mali. However, from the mutation induced progenies from Khao Dawk Mali 105 and Jasmine 85, CLRRI has released several lines being semi-dwarf, high-yielding and slightly aromatic yet non-photoperiod sensitive; those possessing these traits include OM 4900, OM 7347 and OM 6600 (Singh and Khush, 2000). These varieties are referred to slight aromatic rice in the domestic market, and long grain white rice in the international rice market. There is also some long grain rice varieties with no aroma, such as OM 4218, OM 6162 and OM 2517 normally used to produce 5% broken rice for exports. Specific traits of these varieties are specified in Appendix A1. The area of slight aromatic and long grain rice varieties take up around 1,778,513 hectares, accounting for around 50.30% of total rice area in the Mekong Delta. The largest cultivation area occurs during Winter-Spring crop with 796,787 hectares, accounting for 52.98%, followed by Summer-Autumn crop with 794,543 hectares, accounting for 52.03% and Autumn-Winter crop with 197,183 hectares accounting for 37.60%, respectively (MARD, 2011). In the international market, there is not much price difference between slight aromatic rice and normal long grain rice.

Standards of Aromatic Rice Exports from Vietnam

Vietnamese export rice is separated into several types based on the quality, such as long grain 5%, long grain 10% and short grain 15%. These specification standards are based on the Vietnam White Rice Standards, the newest of which is TCVN 5644:2008 (Appendix A2). In these standards, rice export has to be fresh and also free from abnormal flavors, odors and living insects. In addition, rice exports should not contain other contaminants and toxins in amounts which may represent a hazard to human health.

Additionally, Vietnam also exports glutinous and sticky rice, ordinary rice, rice parboiling and fragrant rice. So far, aromatic rice exports from Vietnam do not have their own standards. Most aromatic rice export standards are based on TCVN 5644:2008 (MARD, 2011). In this standard, characteristics or requirements for rice

export are specified, such as length of kernels, percentage of broken rice, percentage of chalky, red, yellow, damaged kernels. The specific standards are summarized in Appendix A2.

Government Programs to Promote High Quality Rice Production

In the Winter-Spring crop 2006/2007, MARD started the program targeting for 1.3 million hectares of high quality rice, in which one million hectare is targeted in the Mekong Delta and 300,000 hectare in Red River Delta. High quality varieties, which are certified by MARD, include white long grain rice varieties and aromatic rice varieties such as Jasmine 85, OM 2517, OM 3536 and ST 5 (MARD, 2011).

In March, 2011, with the aim of producing more high quality rice for exports, MARD launched the program of establishing "large-scale rice field model" in the South of Vietnam. These large-scale rice fields, formed by congregating several small fields from different farmers together, have to use the same high quality rice seeds that are strongly resistant to diseases and unfavorable weather. Farmers who cultivated in these large-scale rice fields applied advanced technologies in farming in order to improve yields and meet rice export standards (MARD, 2012). Under this program, farmers will also benefit from production services, ranging from seeds, soil, and water management to harvesting, preservation, processing and storage. The program is expected to increase rice productivity, quality, value, competitiveness and profit. In order to expand the large-scale rice field model, public institutes, farmers, scientists and traders are required to cooperate in order to focus on the role of business in the areas of processing, purchase, distribution and exports. However, there are no regulations such as requirements to pledge 100% of rice from farmers, to buy rice at previously-agreed prices and to subsidize farmers in case of natural calamities and epidemics for rice companies getting involved in rice cultivation in large-scale rice field model. In other words, contracts are rather informal. Therefore, farmers are still hesitant to participate in the large-scale rice field scheme. After a two-year pilot program, increases of farming areas which is following this model is still slow (MARD, 2012).

CHAPTER IV

RESEARCH METHODOLOGY

Empirical Model and Variables

To reach the first objective, the logit model is used to estimate the probability of aromatic rice adoption. The binary logit model was applied due to the fact that rice farmers in the study area chose only one variety within one season. Therefore, dependent variables of adopt and not adopt is a binary choice determined by rice variety.

To obtain the second objective the change of adoption rate with the change of aromatic rice price is estimated. In this adoption study, the price of the technology is considered to be a crucial factor. The hypothesis is that small price differences and price uncertainty limit Mekong Delta farmers' adoption of aromatic rice varieties. To test this hypothesis, the farmers' responses as well as the change of adoption rates to the scenario about market price change of technology is estimated. Since farmer's responses to a change of the market price of the technology cannot be observed from market data, the contingent valuation survey is used.

In order to estimate the amount of price different that could make farmers change from growing low quality rice to growing aromatic rice, the survey questionnaire including a CV module with single bounded, closed-ended format questions is used in the study. Farmers who did not adopt at the current market price were asked whether they would use the technology at a hypothetical higher price, which varied across farmers. The hypothesis is that each farmer has his own market price that would influence his willingness to adopt the technology.

Jasmine 85 and IR 50404 are the most popular aromatic rice and low quality rice varieties, respectively in the study areas of Mekong Delta based on farmers' responses from the pre-survey, in Winter-Spring season, Jasmine 85 has the higher yield than IR

50404 but also higher cost of investment. Therefore, if the difference in the market prices between these varieties is insignificant, the revenue of growing Jasmine 85 is almost equal the revenue from growing IR 50404. The hypothesis in this study is that without a significant price difference, the income of Jasmine 85 growers and IR 50404 growers is equal. Thus, the difference in prices represents the difference in farmers' income.

Farmers who grow short grain rice (or low quality rice) variety (IR 50404) were asked whether they would be willing to switch to growing aromatic rice if given a specified farm gate price difference from aromatic rice variety (Jasmine 85) and low quality rice variety (IR 50404). The specific question asked to farmers was "Would you be willing to switch to growing Jasmine 85 instead of IR 50404 if the price difference between the two varieties is *t*VND/kg?". *t* is the bid price that was selected from a pre-test questionnaire ranging from 500, 700, 1000, 1500 VND/kg. The bid price is randomly selected to ask for WTA aromatic rice Jasmine 85 of farmers who grow IR 50404 in Winter-Spring season. The answer "yes" or "no" was the output from CV model.

The outcomes for adoption may take on values of 0 or 1, representing whether the farmer is not willing to adopt or willing to adopt aromatic rice, respectively at scenario price differences. If the farmer indicates willingness to adopt at the specified level of price difference (WTA=1) the outcome for adoption decision would be 1, and 0 if the farmer are not willing to adopt, (WTA=0).

From a binary logit model is defined in equation (9), the empirical of factors influenced aromatic rice adoption decision is:

$$\ln\left(\frac{P_A}{P_{NA}}\right) = \beta_0 + \beta_1 \text{FSIZE} + \beta_2 \text{REXPE} + \beta_3 \text{LGREXPE} + \beta_4 \text{AGE} + \beta_5 \text{EDU} + \beta_6 \text{EXTEN} + \beta_7 \text{FASIZE} + \beta_8 \text{WScrop} + \beta_9 \text{AWcrop} + \beta_{10} \text{SASOIL} + \beta_{11} \text{COMSOURE} + \beta_{12} \text{CONTRACT} + \beta_{13} \text{PRICEIM} + \beta_{14} \text{BANDIM} + \beta_{15} \text{DEMONATEN} \quad (17)$$

Where variables are defined in Table 4.1. For the first objective of measuring the probability of aromatic rice adoption, equation (17) is estimated. The probability of adoption is defined based on the equation (7). In order to estimate the marginal effect which denoted as the effect of a unit change of each factor on probability of adoption, we used the equation (10).

Most farmers in the pre-test survey answered that they would change to growing aromatic rice Jasmine 85 if the price difference between IR 50404 and Jasmine 85 would increase high enough, and their neighbors would also change to grow aromatic rice. Therefore, to address this issue a CVM, single bound question is used with the condition that their neighbor would also change to grow aromatic rice variety Jasmine 85 at the given bid price offered.

For the second objective to estimating the probability of adopting aromatic rice variety (Jasmine 85) at different market price among farmers who presently grow low quality rice variety (IR 50404), firstly, willingness to accept the price difference between IR 50404 and Jasmine 85 rice variety is estimated. Then, the probability for IR 50404 growers to switch to growing Jasmine 85 at some levels of price difference between IR 50404 and Jasmine 85.

The logit model measure the willingness to adopt aromatic rice of farmer among non-adopters is specified as

$$\ln\left(\frac{P_A}{P_{NA}}\right) = \beta_0 + \beta_1 \mathrm{AGE} + \beta_2 \mathrm{EXTEN} + \beta_3 \mathrm{HIADOPPRO} + \beta_4 \mathrm{RINCOME} + \beta_5 \mathrm{COMERFA} + \beta_6 \mathrm{MEM} + \beta t_j \quad (18)$$

The dependent variable of adoption decision in equation (18) have two choices, Yes (1) or No (0) of switching to aromatic rice adoption, in response to an offer of different bid prices, t_j (500, 700, 1000, 1500 VND/kg). The independent variables are factors hypothesized to influence farmer's probability of adoption including increase in income or the hypothetical bid price differences. The coefficient

estimates of equation (18) are used to calculate willingness to accept (WTA) for price differences between IR 50404 and Jasmine 85 based on equation (15), and the probability of adoption at hypothetical price difference is estimated based on equation (16). The definitions of explanatory variables in the both two objectives are specified in the Table 4.1. For farmers' perception questions, they were asked, for example, "How much does the risk influence your decision of choosing new rice varieties?" Risk factor in this aromatic rice adoption study can be understood as price uncertainty and production risk including determining input or output quantity, storage (for aromatic rice, storage decrease rice aroma or fragrant; thus it will be risky in term of price if farmers cannot sell their aromatic rice immediately after harvesting), and hedging (aromatic rice will be less fragrant when grown close to non-aromatic rice fields due to the effects of pollination).

Table 4.1 Definition of explanatory variables and hypotheses sign

Variable	Description	Expected sign
Farmer's (head of household's) characteristics		
Education (EDU)	Number of schooling (years)	+
Rice experience (REXPE)	Year of rice cultivation experience (years)	
Long grain rice experience (LGREXPE)	Years of long grain rice varieties cultivation or aromatic rice experience. (years)	+
Age (AGE)	Age (years)	+
Commercial rice farmers (COMERFA)	Sell all rice product (1: Yes, 0: Otherwise).	+
Member of rice associations (MEM)	Being a member of local rice associations	+
Family size (FASIZE)	Number of family member (persons)	+

Table 4.1 (Continued)

Variable	Description	Expected sign
Farm characteristics		
Farm size (FSIZE)	Farm size of rice area (hectare)	+
Soil characteristic	Soil characteristic of famer's rice field	+
Salinity soil (SASOIL)	1: Yes, 0: Otherwise	
Alluvial soil (ALSOIL)	1: Yes, 0: Otherwise	
Acidic soil (ACSOIL)	1: Yes, 0: Otherwise	
External factors		
Extension (EXTEN)	Number of participations in extension training (times per year)	+
Importance of price factor (PRICEIM)	Farmer's attitude toward the important of price factor on their adoption decision is measured using 5-point Likert scale with 1 = not at all important, 2 = slightly important, 3 = moderately important, 4 = very important, 5 = extremely important. Farmer who gives a score higher than 3 indicating favorable attitudes, and score equal or less than 3 indicating unfavorable attitudes. Therefore (1: if 5-point Likert scale ranges from 4 to 5, 0: if 5-point Likert scale ranges from 1 to 3).	+

Table 4.1 (Continued)

Variable	Description	Expected sign
Bandwagon importance (BANDIM)	Perception that neighbor decision on rice varieties is an important factor when choosing rice varieties to grow (1: if 5-point Likert scale ranges from 4 to 5, 0: if 5-point Likert scale ranges from 1 to 3).	-
Winter – Spring crop (WS crop)	Winter – Spring cropping season (1: Yes, 0: Otherwise).	+
Autumn – Winter crop (AW crop)	Autumn – Winter cropping season (1: Yes, 0: Otherwise).	-
Attendance in demonstration (DEMONATEN)	Attended in local demonstration about growing aromatic rice varieties (1: Yes, 0: Otherwise).	+
Contract (CONTRACT)	Having sales contract with private company (1: Yes, 0: Otherwise).	+
Source of seeds (COMSOURE)	Seeds from private rice seed company (1: Yes, 0: Otherwise).	+
Rice income (RINCOME)	Revenue of rice production per year	+
High adoption province (HIADOPPRO)	Highly intensive aromatic rice adoption provinces Can Tho or Soc Trang (1: Yes, 0: Otherwise).	+
Bid price different (t_j)	Bid price difference between aromatic rice Jasmine 85 and low quality rice IR 50404: 500, 700, 1000, 1500 VND/kg	+

Hypotheses

The hypotheses of this research will be tested as follows:

Aromatic rice adoption of farmers in the Mekong Delta are affected by farmers' characteristics, farm characteristics, and other related variables.

Adoption rate of aromatic rice in the Mekong Delta increase correspondingly with the increase of market price difference between aromatic rice and low quality rice.

Sampling Produce

This study employs a three stage, stratified sampling technique to extend questionnaire coverage in the study area. In the first stage, the intensity of aromatic rice adoption is classified by measuring the proportion of aromatic rice area to total crop area from thirteen rice growing provinces in the Mekong Delta. Because the average of the proportion of aromatic rice area to total rice area of all provinces is 14.43%, provinces are separated into two groups. The major group includes the three provinces with the percentage of aromatic rice area over total rice area being greater than 14.43%. The minor group consists of the remaining provinces with the aromatic rice area less than 14.43% (Table 4.2).

Table 4.2 Major and minor aromatic rice zones in Mekong Delta Vietnam

Provinces	Planted paddy area (thousand ha) – 2011	Aromatic rice area (thousand ha)	Percentage of Aromatic rice area (%)
Mekong Delta area	4089.3	590	14.43
Major zone			
Kien Giang	686.9	220	32.03
Can Tho	224.7	60	26.7
An Giang	603.9	100	16.56
Minor zone			
Tien Giang	241.1	23	9.54
Hau Giang	212.7	20	9.4
Long An	486.5	45	9.25
Ben Tre	76.9	7	9.1
Vinh Long	181.5	16	8.82
Tra Vinh	233	20	8.58
Soc Trang	348.9	25	7.17
Đong Thap	501.1	35	6.98
Ca Mau	129.7	8	6.17
Bac Lieu	162.4	10	6.16

Source: MARD (2011)

In the second stage, both rice zones are stratified by their soil characteristics with the assumption that soil characteristics affect farmers' adoption of aromatic rice. There are three main types of soil zones in the Mekong Delta, which include alluvial, acid sulfate, and saline. Based on the characteristics of soil for aromatic rice

production, the Mekong region can be divided into two zones, which include the soft alluvial area and the saline soil area (Table 4.3). Most saline soils are located along coastal areas and have limited uses (Rothuis *et al.*, 1998); these include Kien Giang, Ca Mau, Bac Lieu, Soc Trang, Tra Vinh and Ben Tre. Alluvial soil, usually located along rivers, is agriculturally productive. Saline soils are good soils for the fragrance of aromatic rice, while alluvial soils are good for the yield of aromatic rice.

After completing the second stage, the following districts were randomly selected for a final stage of the survey: Cai Lay, Chau Thanh – Tien Giang; Tan Hiep, Giong Rieng – Kien Giang; Tran De, Long Phu – Soc Trang; Co Do, Thoi Lai – Can Tho (Table 4.3 and Figure 4.1).

For populations that are large, Cochran (2007) developed an equation to yield a representative sample for proportions with the confidence level at 95% as followed:

$$n = \frac{4PQ}{25} \tag{19}$$

Which P is the estimated proportion of an attribute that is present in the population, and *Q* is *1-P*. With the assumption that the proportion of aromatic rice growers in the study area equal 25% the equation (19) becomes

$$n = \frac{4.25.75}{25} = 300\ farmers$$

Base on the above estimation of sample size, 308 households from four provinces are selected for face-to-face interviews. The questionnaire (Appendix C) was used. Farmers are selected randomly and equally in four provinces as shown in Table 4.3.

Table 4.3 The stages of sampling procedure and sample size

Stage 1 Intensity of aromatic rice area	**Stage 2 The soil characteristic for aromatic rice production**	**Selected provinces**	**Stage 3 Randomly selected districts**	**Sample size**
Major aromatic rice provinces: KienGiang, Can Tho, An Giang	Alluvial soil area: Can Tho, An Giang	Can Tho	Co Do, Thoi Lai	75
	Coastal: Kien Giang	Kien Giang	Tan Hiep, Giong Rieng	75
Minor aromatic rice provinces: TienGiang, HauGiang, Long An, Ben Tre, Vinh Long, TraVinh, Soc Trang, Dong Thap, Ca Mau, Bac Lieu.	Alluvial soil area: Tien Giang, Long An, Dong Thap, Vinh Long, Tan An	Tien Giang	Chau Thanh, Cai Lay	75
	Coastal soil area: Soc Trang, Tra Vinh, Ben Tre, Bac Lieu, Ca Mau	Soc Trang	Tran De, Long Phu	75
Total				300

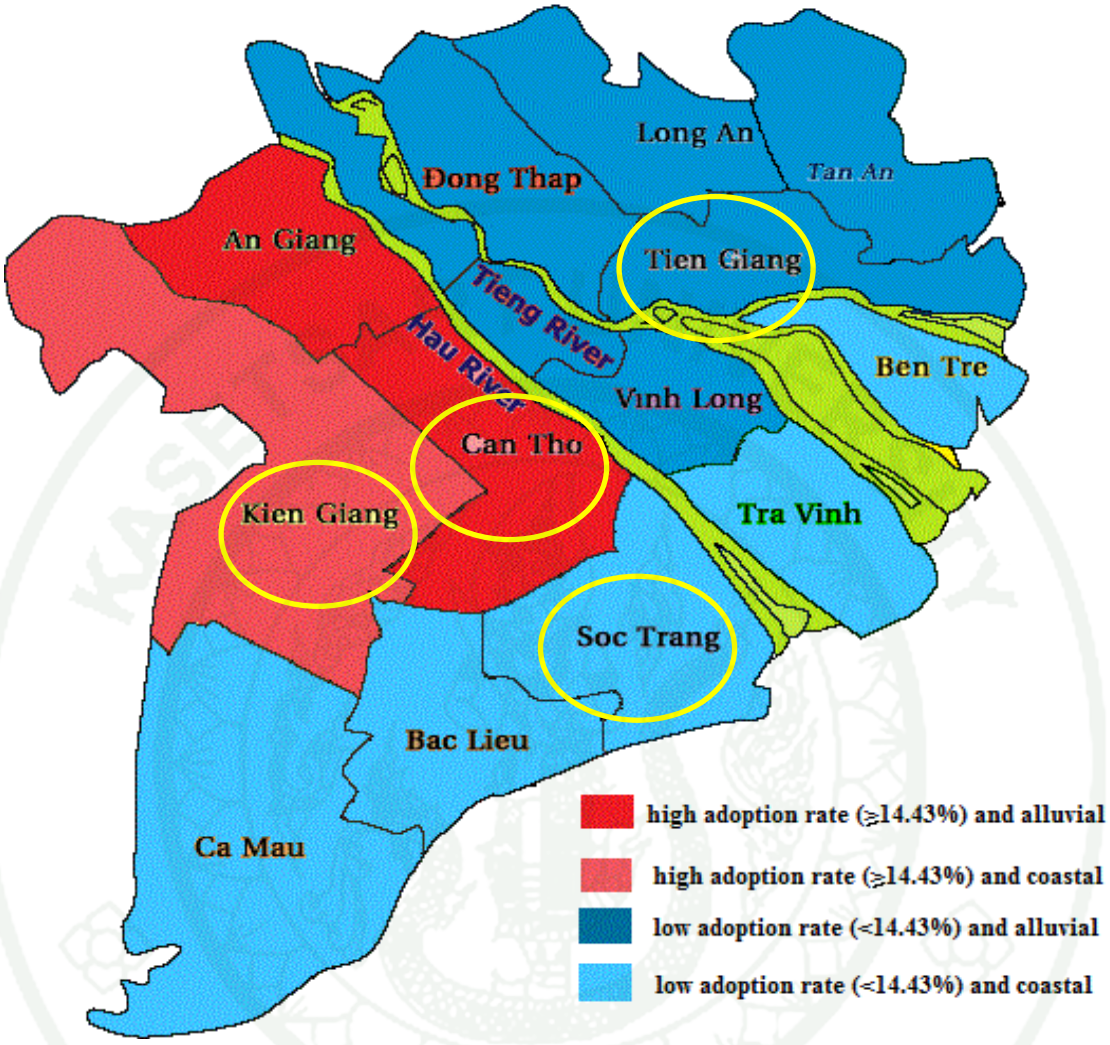

Figure 4.1 Sampling design in the Mekong Delta

Data Collection

The study obtained 308 interviewers from four provinces. Seventy five farmers in each province are selected as 25% total sample size. However, due to the lack of farmers who willing to do the interview in Soc Trang province, the study could only sample 68 farmers (accounting for 91% targeted sample size). The substituted farmers were selected from Kien Giang province as it is the largest rice area province in the study area (General Statistic Office of Vietnam, 2013. Thus, the expected and actual sample sizes of the study are shown in Table 4.4.

Table 4.4 Expected and actual sample size of the study

Study area	Expected sample size (person)	Expected sample proportion	Actual sample Size (person)	Actual sample proportion
Minor aromatic rice zone				
Tien Giang	75	0.25	74	0.24
Soc Trang	75	0.25	68	0.22
Major aromatic rice zone				
Kien Giang	75	0.25	88	0.29
Can Tho	75	0.25	76	0.25
Total	300	1.00	308	1.00

CHAPTER V

RESULTS AND DISCUSSION

Descriptive Statistics

From the survey, the results show that more than one third of the rice area in the study area is covered by aromatic rice varieties (Figure 5.1). Among two main aromatic rice varieties in study area, Jasmine 85 is the dominant variety accounting for 80.32%.

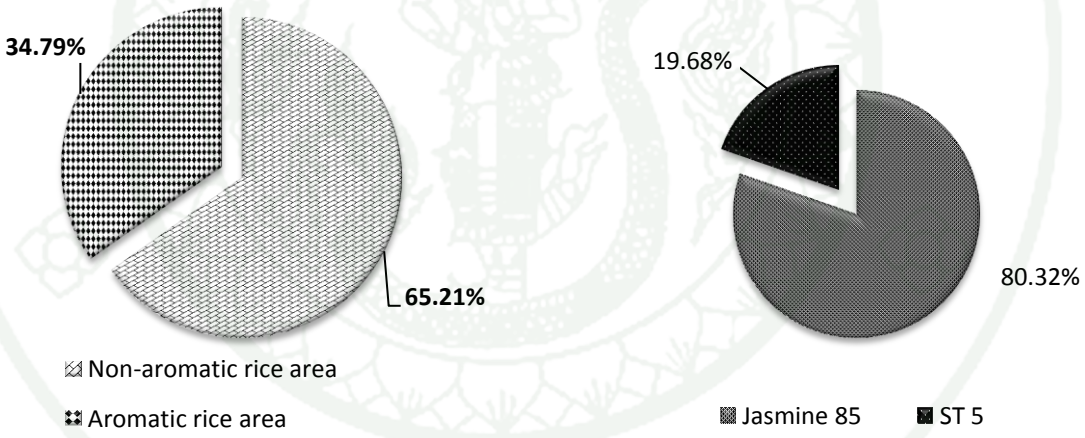

Figure 5.1 Distribution of aromatic rice varieties, Mekong Delta, 2012

Table 5.1 represents average yields of two major aromatic rice varieties grown in the study area (Jasmine 85 and ST 5) and the most popular low quality variety IR 50404. ST 5 has not been grown in other provinces except Soc Trang province, while Jasmine 85 is grown in all four provinces. Jasmine 85 has the highest yield among three rice varieties. In the Winter-Spring season, the average yield of Jasmine 85 is higher than IR 50404 971 kg/ha.

Table 5.1 Average yield of main aromatic rice varieties in study area by cropping season and location, Mekong Delta, 2012/2013.

(Unit: kg/ha)

Study area	Winter-Spring			Summer-Autumn			Autumn-Winter	
	Jasmine 85	ST5	IR 50404	Jasmine 85	ST5	IR 50404	Jasmine 85	IR 50404
Can Tho	10101	-	9130	8833	-	8007	-	7660
Soc Trang		8708	9518	-	8415	9833	-	7890
Kien Giang	10348	-	-	8923	-	8215	8001	7677
Tien Giang	-	-	7710	-	-	6955	7000	6596

Table 5.2 summarizes the demographic characteristics of sampled aromatic rice adopter and non-adopter households in the Mekong Delta. On average, the long grain rice growing experience of adopters is greater than that of non-adopters for nearly two years. However, aromatic rice adopters have less rice growing experience than non-adopters. Long experience of rice farming appeared to constrain new rice variety adoption in this area.

With respect to the size of rice farm households, the number of family members of adopters and non-adopters is almost the same: around five people per household. However there are only two family members participated in rice cultivation (Table 5.2). Laborers are often hired for plowing, harvesting and threshing. In contrast to the farmers in the North of Vietnam, farmers in the Mekong Delta are more like farm managers than laborers.

Table 5.2 Demographic characteristics of aromatic rice farmers, Mekong Delta, 2012

Variables		Adopter		Non-Adopter		All Respondents	
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Farmer characteristics							
Age (years)		49.08	11.52	48.20	11.74	48.40	11.69
Education (years)		6.66	3.52	6.22	3.46	6.32	3.48
Rice experience (years)		24.69	11.74	25.27	12.01	25.13	11.94
Long grain rice experience (years)		7.07	5.24	4.52	6.36	5.11	6.21
Family size (persons)		4.74	1.67	4.82	1.67	4.80	1.67
Number of full-time rice cultivators in a household (persons)		1.98	1.13	1.88	1.15	1.91	1.14
Farm's characteristics							
Farm size (hectare)		2.64	2.94	1.49	2.82	1.76	2.89
Soil type (%)	Alluvial soil	60.85	-	64.54	-	63.68	-
	Coastal soil	1.59	-	3.35	-	2.94	-
	Acidification soil	37.56	-	32.11	-	33.38	-
	Total	100.00		100.00		100.00	
Number of crops per year (%)	2 crops/year	53.44	-	16.77	-	25.28	-
	3 crop/ year	46.56	-	83.23	-	74.72	-
	Total	100.00		100.00		100.00	-
Income (million VND)		137.85	153.02	52.45	103.15	72.25	121.98

It was found that the average number of years of formal education and the average age of aromatic rice adopters are slightly higher than those of non-adopters. The average annual income for aromatic rice adopters is 2.7 times higher than the annual rice income of non-adopters; likewise, the labor-income ratio of adopters is reported to be higher than that of non-adopters. This reveals that the increased purchased inputs required for triple-cropping may have an effect on the reduction in net annual farm income.

The other notable difference between adopters and non-adopters is the number of cropping seasons per year. More than one half of aromatic rice adopters grow only two crops per year while more than 80% of non-adopters cultivate three crops per year (Table 5.2). This is probably because aromatic rice varieties have longer maturation time than non-aromatic rice varieties. Since farmers in the Mekong Delta need to harvest before the flood in July or August, sowing long maturing varieties would be more risky for them as it would extend the third crop which is often from May to August. It's also worth mentioning that hard short grain or low quality rice varieties, which have short maturing time, are preferred in the third season (Autumn – Winter season) rather than long grain or aromatic rice varieties. One third of rice farmers chose low quality rice varieties (IR50404) in their third season.

On average about 2% of rice field is affected by salinization (Table 5.2). Members of local organizations and those attending field demonstrations were more likely to be among aromatic rice adopters than non-adopters.

Table 5.3 summarizes external factors and perception of rice farmers about aromatic rice production in the Mekong Delta. Adopters are likely more advantageous in signing contracts to sell rice to private companies than non-adopters. Sources of rice inputs and outputs were different between aromatic adopters and non-adopters. While 82.54% aromatic rice growers bought seeds mostly from private rice seed companies, there was a significant proportion (32.75 %) of non-adopters producing seeds by themselves or buying seeds from their neighbors (Table 5.3). Though, being the biggest rice research institute in Vietnam, CLRRI still plays a minor role in

supplying rice seeds to farmers in the Mekong Delta; there are only 8.34% farmers buying seeds from this institute (Table 5.3).

About 12.42% of farmers had no contact with extension agents (Table 5.3). The maximum number of contacts is 22 times/year. Those who have high-frequency of extension contacts were most likely with local officers. Adopters seem to be more active in participating in extension training programs than non-adopters. In general, the participation of farmers in the Mekong Delta in local associations or groups has been little since there are only eight out of 100 farmers who are members of farmers' associations (Table 5.3).

In this study, farmers' perception on price, maturing time of new rice varieties, risk and bandwagon effect was four important hypothesized factors related to probability of aromatic rice adoption.

In general, farmers ranked it as moderately important factor on their adoption of new rice varieties (Table 5.3). Farmers in the Mekong Delta highly ranked price as as important factor in choosing their varieties. Aromatic rice adopters are likely to rank importance for price higher than non-adopters.

Bandwagon factor denotes the effect of neighbors' choices on farmers' decision of adopting a new rice variety. In the Mekong Delta, irrigation system is established and maintained by government agencies. During the harvest time, when rice is almost ready to harvest, local agencies close the dam for farmers, making it easier to harvest their crops. Therefore, farmers who grown much longer maturing varieties than their neighbors will be affected. In addition, most rice is sold directly to collectors on farmers' fields. The collectors then transport it by boat; thus, they prefer to buy the same variety in large amount (enough for one rice boat, around 20 to 30 tons). Thus, it will be difficult to sell rice if small farms grow a different variety from their neighbors. That is the reason why farmers ranked high for this factor (Table 5.3).

Table 5.3 External factors and perception of rice farmers about aromatic rice production, Mekong Delta, 2012

Variables		Adopter		Non-Adopter		All Respondents	
		Mean	SD	Mean	SD	Mean	SD
External factors							
Extension training participations (times/year)		5.41	4.54	4.44	4.36	4.67	4.42
Member of farmers association (%)		11.24	32.73	7.05	26.13	8.25	27.73
Contract with company (%)		14.98	35.73	7.13	26.35	9.14	28.06
Source of seed (%)	Private seed company	82.54	-	51.28	-	58.53	-
	Local seed groups	5.29	-	6.87	-	6.50	-
	Self-producing	6.35	-	32.75	-	26.63	-
	Governmental institute	5.82	-	9.10	-	8.34	-
	Total	100.00		100.00		100.00	-
Farmer perceptions toward aromatic rice							
Importance level of price factor		4.23	0.99	3.83	1.20	3.92	1.17
Importance level of maturing time factor		2.43	1.17	2.62	1.23	2.58	1.22
Importance level of risk factor		1.95	1.10	2.23	1.14	2.16	1.14
Importance level of bandwagon factor		4.02	1.01	4.41	0.83	4.32	0.89

Note: Important level of factors are measured using 5-point Likert scale approach with 1 = not at all important, 2 = slightly important, 3 = moderately important, 4 = very important, 5 = extremely important.

In conclusion, the adopter and non-adopter households ranked differently for the importance of factors influencing their selection of rice varieties. Adopters considered price as an importance factor influencing their adoption decision while non-adopters ranked higher for bandwagon factor (Table 5.3), meaning that their neighbors' adoption decision has more influence on their adoption than market price.

In the second objective, non-adopters, who grow low quality rice varieties IR50404 are asked for their willingness to adopt aromatic rice variety Jasmine 85. Thus, descriptive statistics for IR 50404 growers to know characteristics of low quality rice growers compared to aromatic rice growers are defined (Table 5.4).

On average, low quality rice growers have higher rice cultivation experience, possess less education and are a little younger than aromatic rice growers. With respect to farm characteristics, IR 50404 growers have smaller farm size, and receive lower farm gate price than Jasmine 85 growers by 713 Vietnam dong/ kg (Table 5.4).

Regarding farm characteristics, the majority of IR 50404 growers cultivate three crops per year accounting for 96.43%, while there is more than one half of Jasmine growers cultivate only two crops per year (Table 5.4).

For perception of farmers, IR 50404 growers ranked highest for bandwagon factor with 4.73 on 5-Likert scale (Table 5.4). They suppose that their neighbors' choice is decisive factor influencing them in choosing a variety to grow in the next crop. While Jasmine 85 growers consider more about current market price when they choose which variety to grow; they ranked high for price factor with 4.14 on 5-Likert scale.

Table 5.4 Characteristics of low quality rice variety IR 50404 growers compare with aromatic rice Jasmine 85 growers, Mekong Delta, 2012

Variables		IR 50404 Grower		Jasmine 85 Grower	
		Mean/%	Std. dev	Mean/%	Std. dev
Farmers' characteristics					
Age (years)		47.16	9.07	47.96	11.46
Education (years)		5.68	3.15	6.69	3.43
Rice experience (years)		26.21	10.62	24.34	11.03
Farm characteristics					
Farm size (hectare)		1.34	4.49	2.23	2.47
Number of crops per year	2 crops /year (%)	3.57	-	40.88	-
	3 crop /year (%)	96.43	-	59.12	-
	Total	100.00		100.00	
Output Price (VND/kg)		4434.82	371.47	5165.18	525.35
External factors and farmer perceptions toward technology					
Importance level of price factor		3.00	1.40	4.14	1.06
Importance level of bandwagon factor		4.73	0.52	4.00	1.03
Number of extension training participations (times/year)		4.50	4.76	5.44	4.61
Source of seed	Private seed company (%)	30.36		79.56	
	Others (%)	69.64	-	20.44	
	Total	100.00		100.00	

Jasmine 85 growers joined more extension programs and had a stronger supply connection than IR 504 growers. Other external variables were not significantly different between IR 50404 growers and Jasmine 85 growers.

Adoption of Aromatic Rice in Mekong Delta

The results of the coefficient estimates of aromatic rice adoption logit model and the marginal effects of explanatory variables are presented in Table 5.5. The results showed that all explanatory variables, except for family size, education and soil acidification, are significant.

Experience in rice cultivation has a negative relationship on probability of aromatic rice adoption. This suggests that the longer rice farming experience farmers have, the lower is their probability to adopt aromatic rice varieties, since they are more reluctant to adjust to new technology and cultivation practices. This result is similar to (Li *et al.*, 2010). However, the experience in growing long grain rice varieties increases the probability of adopting aromatic rice. This may reveal that at the early stage of aromatic rice adoption, farmers who have more experience with growing long grain are likely to adopt aromatic rice as well.

The coefficient of farm size was found to be positively related with the adoption of aromatic rice varieties. This finding is contrary to Shiyani *et al.* (2002) that small farmers adjust quickly and are more likely to adopt new crop varieties than large farmer. However, this finding is consistent with other studies about improved rice varieties adoption (Mariano *et al.*, 2012; Saka and Lawal, 2009). This is probably because rice cultivation is main occupation in Mekong Delta, and larger farm size implies higher capital and income. Since aromatic rice varieties requires more investment in term of fertilizer and labor, richer farmers are more likely to adopt aromatic rice as they can afford the higher cost of production.

Table 5.5 Coefficient estimates of logit model of aromatic rice adoption and marginal effects

Variables	Coefficient estimates		Marginal effect	
	Coeff.	**Std. Err.**	**Coeff.**	**Std. Err.**
FSIZE	0.0001***	0.0000	0.0000***	0.0000
REXPE	-0.0336**	0.0135	-0.0028**	0.0011
LGREXPE	0.0811***	0.0189	0.0067***	0.0017
AGE	0.0292**	0.0136	0.0024**	0.0011
EDU	-0.0250	0.0348	-0.0021	0.0029
EXTEN	0.0743**	0.0265	0.0062**	0.0023
FASIZE	-0.0838	0.0670	-0.0070	0.0056
WS crop	4.2480***	0.5158	0.3531***	0.0397
AW crop	-1.2293**	0.5279	-0.1022**	0.0399
SASOIL	0.1431	0.2430	1.1539	0.2804
COMSOURE	1.8886***	0.2742	0.1570***	0.0255
CONTRACT	1.2266**	0.3849	0.1020**	0.0335
PRICEIM	0.6280**	0.2947	0.0522**	0.0248
BANDIM	-0.7564**	0.3231	-0.0629**	0.0276
DEMONATEN	1.3550***	0.3982	0.1126***	0.0341

Number of observations: 815

Log likelihood = -252.82767

Pseudo R^2 = 0.4276

*** Statistically significant at 99% (P value<0.001)

** Statistically significant at 95% (P value<0.05)

* Statistically significant at 90% (P value<0.10)

Cropping season is found significantly related to the probability of aromatic rice adoption. Winter-Spring (WS) season increases the probability of adopting aromatic rice varieties while Autumn-Winter (AW) decreases it. The marginal effect

is 0.3531, indicating that farmers in Mekong Delta are 35.31% more likely to adopt aromatic rice in WS season than two other season (Winter-Spring and Autumn-Winter season), (Table 5.5). This is obviously expected because shorter maturing duration of non-aromatic rice varieties can escape the risk of the annual flood starting in July so farmers are more likely to cultivate non-aromatic rice in AW season. It is possibly because farmers who adopt aromatic rice varieties namely ST 5 and Jasmine 85 in both WS and Summer-Autumn (SA) crops normally skip the third season. Besides some non-aromatic and low quality rice varieties are preferred by the farmers in Mekong Delta because of early maturing than aromatic rice varieties.

The intensity of extension contacts is positively related to probability of aromatic rice adoption, implying that the likelihood of aromatic rice adoption increases along with the communication with extension agents. In other words, farmers with more exposure to extension officers are more likely to adopt aromatic rice varieties.

The variables representing soil characteristics were expected to have a strong influence on the on adoption of aromatic rice, but due to the characteristics of one of two most popular aromatic rice varieties (specifically ST 5), being saline-tolerant and acid-tolerant, in the study area, acidification soil does not significantly influence aromatic rice adoption. It is worth mentioning that market prospect of aromatic rice especially the trend of current price of aromatic rice certainly influences the adoption decision. Farmers who consider price as an important factor, their likelihood of adopting aromatic rice is 5.22% higher than farmers who consider price as an unimportant factor. On the contrary, non-adopters may think that the rice variety chosen by their neighbors is important and decisive factor on which rice variety they should grow. This is imply that for aromatic rice production in the Mekong Delta, the perception of the importance of bandwagon factor decreases farmer's probability of aromatic rice adoption.

Though education plays a significant role in the adoption decision, this factor is not significant in adoption decision of aromatic rice varieties in the Mekong Delta. This is consistent with Saka and Lawal (2009) who did not find a significant relationship between education and improved rice varieties adoption in Nigeria. This may be because most of family members are not labor force for rice production but hired workers. Even though aromatic rice production is more labor intensive, the number of family members doesn't influence its adoption.

The results also show that contracts with processing companies significantly increase the probability of adopting aromatic rice. Such pattern is expected because price certainty encourages farmer to choose rice varieties which bring them the highest profit. In addition, most private companies prefer to use aromatic rice for their exports so recommendation to produce aromatic rice can be expected.

Farmers' WTA Aromatic Rice in Mekong Delta

The mean of WTA the price difference between IR 50404 and Jasmine 85 is estimated at 1,085 VND/kg, while the average current difference market price between the two varieties from the survey is 734 VND/kg.

The binary regression model was estimated for sixty non-adopters who grow low quality rice varieties, IR 50404. The results showed that factors, namely age, commercial rice farmers, household's rice income, number of extensions per year, bid price difference are significantly related to farmer's willingness to switch to aromatic rice variety Jasmine 85 (Table 5.6).

With respect to extension, the coefficient of extension variables is significant in the model indicating that the relative higher number of extensions the IR 50404 growers have, the higher their probability of switching to grow aromatic rice.

Regarding the location, IR 50404 growers from highly intensive aromatic rice adoption provinces including Can Tho and Soc Trang are more likely to agree to switch to growing Jasmine 85 from IR 50404 growers than other provinces. This result indicates that farmers seemed more confident to adopt the rice variety that has been grown by many others in their province.

In terms of rice income, those who have higher rice income are less likely to change to grow aromatic rice. This finding is consistent with the results of Li *et al.* (2010) which indicated that the higher income farmers have, the lower probability that they will change over to a new technology which is more risky than their conventional technology.

Table 5.6 Coefficient estimates of WTA switching to aromatic rice adoption and marginal effects

Variables	Coefficient estimates		Marginal effects	
	Coeff.	**Std. Err.**	**Coeff.**	**Std. Err.**
t_j	0.0060***	0.0019	0.0012***	0.0004
AGE	-0.1060**	0.0515	-0.0212**	0.0103
EXTEN	0.2908**	0.1260	0.0581**	0.0261
HIADOPPRO	6.8992***	2.1390	1.3775***	0.4181
RINCOME	-0.1331	0.0906	-0.0266	0.0183
COMERFA	-2.4729*	1.3079	-0.4937*	0.2781
MEM	-2.7212*	1.6219	-0.5433*	0.3194

Number of observations: 60

Log likelihood = -17.7012

Pseudo R^2 = 0.5568

*** Statistically significant at 99% (P value<0.001)

** Statistically significant at 95% (P value<0.05)

* Statistically significant at 90% (P value<0.10)

The result showed that bid price is one significant factor associated with farmers' willingness to switch to grow aromatic rice. The marginal effect indicated that if the market price increases 100 VND, the probability of farmers' willingness to change to grow aromatic rice will increase 0.12 (Table 5.6).

In order to estimate how much the price difference would be able to encourage farmers to change from producing low quality rice variety IR 50404 to growing aromatic rice variety Jasmine 85, the mean of WTA is calculated from equation (17). The result of willingness to accept aromatic rice by switching from IR 50404 to Jasmine 85 is defined in the table 5.7.

Table 5.7 Willingness-to-accept (WTA) aromatic rice by switching from IR 50404 to Jasmine 85

Variables	**Coefficient estimates (α)**	**Mean of z_j**	**$\alpha * z_j$**
t_j	0.0060	925.0000	-
AGE	-0.1060	46.3833	-4.9185
EXTEN	0.2908	4.3667	1.2699
HIADOPPRO	6.8992	0.6500	4.4845
RINCOME	-0.1331	40.0342	-5.3266
COMERFA	-2.4729	0.7167	-1.7722
MEM	-2.7212	0.1167	-0.3175
Cons	0.0354	-	-
Mean of WTA	1,085		

Base on the results, 95% of farmers said that they are willing to change from growing low quality rice IR 50404 to growing Jasmine 85. Only 5% of respondents said that they won't change to growing aromatic rice variety Jasmine 85 at any bid price offer. The reasons of not being willing to change are mostly because they think IR 50404 is easier to grow, requires less investment, and is less risky to grow than

Jasmine 85. Around 38.33% of respondents agreed with the bid price offered, and 61.67% said "No" with the bid price offered.

In order to estimate the probability of low quality rice growers to adopt aromatic rice Jasmine 85, the probability of adoption at hypothetical price differences between the low quality rice and the aromatic rice variety is calculated. The result reveals the difference in market prices between these two varieties ranged from 500 to 700 VND/kg; the probability of willingness to adopt Jasmine 85 of low quality rice growers ranges only from 1.98% to 7.55% with the condition that their neighbors would change to grow the Jasmine 85 variety. However, the probability increased to 39.82% and 95.58% when the price difference is 1000 VND/kg and 1500 VND/kg respectively. From the equation (16), the probability of adopting at different levels of price is calculated as follow:

$$P_{A(t_j)} = \frac{e^{\alpha z_j + \beta 500}}{(1+e^{\alpha z_j + \beta 500})} = 0.0275.$$

The probability that LQR growers will switch to aromatic rice Jasmine 85 can similarly be calculated at 700 VND/kg, 1000 VND/kg, 1500 VND/kg resulted in 0.0864, 0.3660, 0.9217, respectively (Table 5.8).

Table 5.8 Estimation of probability of adopting aromatic rice variety Jasmine 85 at different hypothetical market price difference

Price difference	**500 VND/kg**	**700 VND/kg**	**1000 VND/kg**	**1500 VND/kg**
Percentage of farmers saying yes with bid price	0	26.67	53.33	73.33
Probability of willingness to change to grow Jasmine 85	0.0275	0.0864	0.3660	0.9217

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This paper investigates factors influencing the adoption of aromatic rice for the government's target of improving quality for Vietnamese exporting rice. This study employed a farm survey of 2012/2103 rice production by a face-to-face interview with 308 rice farmers in the Mekong Delta, which is one of two major rice production areas contributing 90% of the volume of rice export from Vietnam.

The binomial logit model was estimated to find out the factors correlating with the of aromatic rice adoption. This study concludes that extension contacts, demonstration participants, and connection with private companies through seed supply and output contract positively related to the probability of aromatic rice adoption, but rice growing experience and autumn-winter season negatively related to it.

This study does not find evidence that soil type affected farmers' adoption decision to grow aromatic rice. This implies that aromatic rice has a potential to extend to other non-adopting areas. Farmers in the Mekong Delta are likely to grow aromatic rice in the Winter-Spring season and grow non-aromatic rice in the Autumn-Winter season. This reveals that, with the geographic and weather conditions in the Mekong Delta, the long maturing time of aromatic rice varieties might be a constraint for farmers to adopt aromatic rice in the Autumn-Winter season.

There is no statistically significant evidence that the probability of aromatic rice adoption depends on a farmer education. However, aromatic rice adoption decision is positively related to long grain rice experience and negatively involved in

rice cultivation experience. This implies that farmers who have less rice growing experience and more long grain rice growing experience tend to adopt aromatic rice than their counterparts. Therefore, any effort to improve adoption rates of aromatic rice should be targeted to these groups of farmers.

Connections between farmers and rice companies have shown effects on the probability of aromatic rice adoption. Therefore, factors aimed at increasing or strengthening connections between rice farmers and companies through supplying seed or signing contracts with farmers will to improve the adoption of aromatic rice. Attendance at local demonstrations for new rice varieties will also help increasing farmers' knowledge and confidence of growing new or high risk varieties, hence increasing the adoption of aromatic rice varieties.

This research continues to confirm that market price is important factor on farmers' adoption decisions of aromatic rice varieties. It is evident that marketing strategies could help encouraging farmers to adopt more aromatic rice varieties.

The results indicate that willingness to switch from non-adopter to adopter of aromatic rice is positively influenced by bid price differences, the number of extensions, and high adoption rate provinces. However, it is negatively influenced by rice income, age and those who don't consume their rice but sell all of their rice production.

At the present time, the market price difference between AR and LQR varieties is 734 VND/kg, but those farmers growing low quality rice would be willing to accept a switch to aromatic rice if there were a price difference of 1,085 VND/kg on average. This finding reveals that marketing strategies to increase the price difference between AR and LQR is one of the ways to increase the adoption rate of AR and reduce LQR area in the Mekong Delta.

Recommendations

Extension services should be strengthened since it is evident that they provide growing skills to farmers, hence increasing probability of aromatic rice adoption. However, these should go hand in hand with strengthening connection between farmers and rice companies in order to secure farm gate price.

A challenge faced by non-adopters was the bandwagon factor that makes farmers' adoption decisions be based upon their neighbors' choice of varieties. Therefore, organizing farmers into cluster to sell rice product rather than individually will help to access better markets. This would also help to increase farmers' market power in terms of their rice product.

With respect to the importance of farmers' groups and farmers' associations, the results also indicated that a significant relationship existed between membership to farmer groups and probability of aromatic rice adoption. This is the foremost strategy used by extension officers to encourage adoption of new technology. Formation of such groups would also aid in countering rice collectors, who have higher bargaining power than farmers who have small rice fields and are unable to produce large amounts of rice even if they grow high quality rice or aromatic rice varieties. Adoption rates of aromatic rice could grow considerably if all of the aforementioned recommendations are implemented.

Area for Further Research

Even though the empirical result from this study provides interesting findings, there are still opportunities for future studies in this area for improving the understanding of aromatic rice in the Mekong Delta, Vietnam.

Firstly, our research provides evidence that the increase in price difference between LQR and AR can make farmers switch from growing LQR to growing AR, and give the mean of WTA price difference between two types of varieties in Winter-

Spring season only. Since two remaining cropping seasons (Summer-Autumn and Autumn-Winter) require more investment and have lower yields, the WTA for price difference might be different and have not yet been estimated.

Secondly, since farmers are uncertain about choosing which type of rice they should produce, the impact assessment of aromatic rice technology on yield and household's income in comparing with non-aromatic or low quality rice can give direct recommendations to farmers. Since the impact assessment of aromatic rice technology was not done, this might be fertile ground for further research.

LITERATURE CITED

Abdullah A.B., Ito S., Adhana K. 2006. **Estimate of rice consumption in Asian countries and the world towards 2050.** Proceedings for Workshop and Conference on Rice in the World at Stake. 2: 28-43.

Alonge, A.J. and R.A. Martin. 1995. "Assessment of the Adoption of Sustainable Agriculture Practices: Implications for Agricultural Education." **Journal of Agricultural Education** 36(3): 34-42.

Asante, M.D., B.O. Asante, G.K. Acheampong, A.N. Wiredu, S.K. Offei, V. Gracen, H. Adu-Dapaah and E.Y. Danquah. 2013. "Grain Quality and Determinants of Farmers' Preference for Rice Varietal Traits in Three Districts of Ghana: Implications for Research and Policy." **Journal of Development and Agricultural** 5(7): 284-294.

Asrat, S., M. Yesuf, F. Carlsson and E. Wale. 2010. "Farmers' Preferences for Crop Variety Traits: Lessons for on-Farm Conservation and Technology Adoption." **Ecological Economics** 69(12): 2394-2401.

Beltran, J.C., B. White, M. Burton, G.J. Doole and D.J. Pannell. 2013. "Determinants of Herbicide Use in Rice Production in the Philippines." **Agricultural Economics** 44(1): 45-55.

Bruinsma J. 2003. **World agriculture: towards 2015/2030. An FAO perspective.** Earthscan Publications Ltd., London.

Caswell, M. and D. Zilberman. 1985. "The Choices of Irrigation Technologies in California." **American Journal of Agricultural Economics** 67(2): 224-234.

Chi, T.T.N. and R. Yamada. 2002. "Factors Affecting Farmers' Adoption of Technologies in Farming System: A Case Study in Omon District, Can Tho Province, Mekong Delta." **Omonrice** 10(2): 94-100.

Cochran, W.G. 2007. **Sampling Techniques**. John Wiley & Sons, New York.

Daberkow, S.G. and W.D. McBride. 2003. "Farm and Operator Characteristics Affecting the Awareness and Adoption of Precision Agriculture Technologies in the Us." **Precision Agriculture** 4(2): 163-177.

David, C.C. and K. Otsuka. 1994. **Modern Rice Technology and Income Distribution in Asia.** Lynne Rienner Publishers, Boulder, Colorado & International Rice Research Institute (IRRI), Manila.

Diagne, A. 2006. "Diffusion and Adoption of Nerica Rice Varieties in Côte D'ivoire." **The Developing Economies**. 44(2): 208-231.

Drost, D., G. Long and K. Hales. 1998. "Targeting Extension Efforts for the Adoption of Sustainable Farming Practices." **Journal of extension** 36(5): 53-63.

Ekasingh, B. and R. Letcher. 2008. "Successes and Failures to Embed Socioeconomic Dimensions in Integrated Natural Resource Management Modeling: Lessons from Thailand." **Mathematics and Computers in Simulation** 78(2): 137-145.

Evans, L.T. 1998. **Feeding the Ten Billion: Plants and Population Growth.** Cambridge University Press, London.

Food and Agriculture Organization of the United Nations (FAO). 2014. **Fao Rice Price Update** (Online). http://www.fao.org/economic/est/publications/rice-publications/the-fao-rice-price-update/en/, September 20, 2014.

Fernandez-Cornejo, J., E.D. Beach and W.-Y. Huang. 1994. "The Adoption of Ipm Techniques by Vegetable Growers in Florida, Michigan and Texas." **Journal of Agricultural and Applied Economics** 26(3): 158-158.

Feder, G., R.E. Just and D. Zilberman. 1985. "Adoption of Agricultural Innovations in Developing Countries: A Survey." **Economic development and cultural change** 33: 255-298.

Fitzgerald, M.A., S.R. McCouch and R.D. Hall. 2009. "Not Just a Grain of Rice: The Quest for Quality." **Trends in plant science** 14(3): 133-139.

Gerhart, J.D. 1974. **The Diffusion of Hybrid Maize in Western Kenya.** CIMMYT, Mexico.

General Statistics Office of Vietnam (GSO). 2013. **Paddy area by provinces in Vietnam** (Online). http://www.gso.gov.vn/default.aspx?tabid=390&idmid=3&ItemID=15298, August 15, 2014.

Giraud G. 2013. "The World Market of Fragrant Rice, Main Issues and Perspectives." **International Food and Agribusiness Management Review** 16(2): 1-20.

Gockowski, J. and M. Ndoumbé. 2004. "The Adoption of Intensive Monocrop Horticulture in Southern Cameroon." **Agricultural Economics** 30(3): 195-202.

Griliches, Z. 1957. "Hybrid Corn: An Exploration in the Economics of Technological Change." **Journal of the Econometric Society** 25(4): 501-522.

Haab, T.C. and K.E. McConnell. 2002. **Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation**. Edward Elgar Publishing, United Kingdom.

Hardaker, J.B., Huirne, R.B.M., Anderson, J.R. 1997. **Coping with Risk in Agriculture**. CABI Publishing, United Kingdom.

He, X.-F., H. Cao and F.-M. Li. 2007. "Econometric Analysis of the Determinants of Adoption of Rainwater Harvesting and Supplementary Irrigation Technology (Rhsit) in the Semiarid Loess Plateau of China." **Agricultural water management** 89(3): 243-250.

Huffman, B.J. 2004. "Why Environmental Scanning Works except When You Need It." **Business Horizons** 47(3): 39-48.

Kaliba, A.R., H. Verkuijl and W. Mwangi. 2000. Factors Affecting Adoption of Improved Maize Seeds and Use of Inorganic Fertilizer for Maize Production in the Intermediate and Lowland Zones of Tanzania. **Journal of Agricultural and Applied Economics**. 32(1): 35-48.

Kijima, Y. and D. Sserunkuuma. 2008. "The Adoption of Nerica Rice Varieties at the Initial Stage of the Diffusion Process in Uganda." **African Journal of Agricultural and Resource Economics Volume** 8(1): 45-56.

Kim, S., J.M. Gillespie and K.P. Paudel. 2005. "The Effect of Socioeconomic Factors on the Adoption of Best Management Practices in Beef Cattle Production." **Journal of Soil and Water Conservation** 60(3): 111-120.

Krejcie, R.V. and D.W. Morgan. 1970. "Determining Sample Size for Research Activities." **Educational and psychological measurement** 30(3): 607-610.

Langyintuo, A. and M. Mekuria. 2008. "Assessing the Influence of Neighborhood Effects on the Adoption of Improved Agricultural Technologies in Developing Agriculture." **African Journal of Agricultural and Resource Economics** 2(2): 151-169.

Li, D., M. Liu and G. Deng. 2010. "Willingness and Determinants of Farmers' Adoption of New Rice Varieties." **China Agricultural Economic Review** 2(4): 456-471.

Likert, R. 1932. **A Technique for the Measurement of Attitudes**. Archives of Psychology, New York.

Maddala, G.S. and K. Lahiri. 1992. **Introduction to Econometrics**. Addison-Wesley, New York.

Mariano, M.J., R. Villano and E. Fleming. 2012. "Factors Influencing Farmers' Adoption of Modern Rice Technologies and Good Management Practices in the Philippines." **Agricultural Systems** 110(2): 41-53.

Noorhosseini-Niyaki, S.A. and M.S. Allahyari. 2012. "Logistic Regression Analysis on Factors Affecting Adoption of Rice-Fish Farming in North Iran." **Rice Science** 19(2): 153-160.

Otsuka, K. and T. Yamano. 2006. "Introduction to the Special Issue on the Role of Nonfarm Income in Poverty Reduction: Evidence from Asia and East Africa." **Agricultural Economics**. 35(3): 393-397.

Pachauri V., Singh M.K., Singh A.K., Singh S., Shakeel N., Singh V.P., Singh N.K. 2010. "Origin and genetic diversity of aromatic rice varieties, molecular breeding and chemical and genetic basis of rice aroma." **Journal of Plant Biochemistry and Biotechnology** 19(2): 127-143.

Papademetriou M.K., Dent F.J., Herath E.M. 2000. **Bridging the Rice Yield Gap in the Asia-Pacific Region FAO Regional Office for Asia and the Pacific.** FAO publication, United Nation.

Paudel, K.P., H. Zapata and D. Susanto. 2005. "An Empirical Test of Environmental Kuznets Curve for Water Pollution." **Environmental and Resource Economics** 31(3): 325-348.

Rahm, M.R. and W.E. Huffman. 1984. "The Adoption of Reduced Tillage: The Role of Human Capital and Other Variables." **American journal of agricultural economics** 66(4): 405-413.

Rodriguez D.G.P., Nga N.T.D. 2012. **Impacts of Site-Specific Nutrient Management in Irrigated Rice Farms in the Red River Delta, Northern Vietnam.** Paper presented at the International Association of Agricultural Economists conference, Foz do Iguacu, Brazil, August 18-24.

Rogers, E. M. 2003. **Diffusion of Innovations**. Free Press: A Division of Simon & Schuster Inc, New York.

Rothuis, A., D. Nhan, C.J. Richter and F. Ollevier. 1998. "Rice with Fish Culture in the Semi-Deep Waters of the Mekong Delta, Vietnam: A Socio-Economical Survey." **Aquaculture research** 29(1): 47-57.

Sain, G. and J. Martínez. 1999. **Adoption and Use of Improved Maize by Small-Scale Farmers in Southeast Guatemala.** CIMMYT, Mexico.

Saka, J. and B. Lawal. 2009. "Determinants of Adoption and Productivity of Improved Rice Varieties in Southwestern Nigeria." **African Journal of Biotechnology** 8(19): 4923-4932.

Schultz, T.W. 1975. "The Value of the Ability to Deal with Disequilibria." **Journal of Economic Literature** 13(3): 827-846.

Shiyani, R., P.K. Joshi, M. Asokan and M. Bantilan. 2002. "Adoption of Improved Chickpea Varieties: Kribhco Experience in Tribal Region of Gujarat, India." **Agricultural Economics** 27(1): 33-39.

Singh R.K., Khush G.S. 2000. **Aromatic rices**. Oxford & IBH Publishing, United Kingdom.

Tuong, D.M. 2010. "Economic Analysis on Production of High Quality Rice in Cuulong Delta, Vietnam." **Omonrice** 17(3): 174-178.

Train, K. 2003. **Discrete choice methods with simulation.** Cambridge University Press, United Kingdom.

Vietnam standard (TCVN). 1999. **Rice - Term and Definition** (Online). http://thuvienkhcn.vinhlong.gov.vn/tailieukhcn/data/TieuChuantoanvan/GAO/TCVN_5643_1999.pdf, December 10, 2014.

Vietnam Ministry of Agriculture and Rural Development (MARD). 2011. **Achievement and limittation of high-yield rice varieties adoption in Mekong Delta** (Online). http://cayluongthuc.blogspot.com/2011/08/thanh-tuu-va-gioi-han-cua-viec-ap-dung.html, August 11, 2014.

Vietnam Ministry of Agriculture and Rural Development (MARD). 2012. **Result of launching the program of establishing "large-scale rice field model" in Summer-Autumn season 2011 - Winter-Spring season 2011-2012 and its development orientation in the coming time in Vietnam** (Online). http://vnclp.gov.vn/uploaded/2013/21/09/2fa9cbba-a082-4e7f-b720-25361767d8a0.doc, August 20, 2014.

Wang, H., S. Pandey and O. Velarde. 2012. "Pattern of Adoption of Improved Rice Varieties and Its Determinants in Cambodia." **Procedia Economics and Finance** 2(3): 335-343.

APPENDICES

Appendix A

Aromatic Rice Adoption in the Mekong Delta

Appendix A1 Characteristics of popular rice varieties in Mekong Delta

Group	Varieties	Duration (days)	Average yield (tons)	Target area for growing	Source of parental line	Year of release
Aromatic rice	Jasmine 85	95-110	Winter – Spring: 7-10 tons Sumer – Autumn: 4-7 tons	MD	IRRI	1992
	ST 5	115-120	6-8 tons	MD	DARD ST	2002
	Khao Dawk Mali		5-7 tons	Long An	IRRI	1992
	Nang thomcho dao	250-270	2-3 tons	Long An	Local	1950
	VD 20	100-115	Winter – Spring: 6-7 tons Sumer – Autumn: 4-5 tons	MD	VASS	1999
	Nang huong	155-165	3-3.2 tons	LA, ST	Local	1960
Long grain, good quality rice	OM 4900	95-100	7-8 tons	MD	CLRRI	2008
	OM 5451	90-95	5-8 tons	MD	CLRRI	2010
	OM 4218	90-95	6-8 tons	MD	CLRRI	2010
	OM 7347	90-95	6-8 tons	MD	CLRRI	2009
	OM 3635	85-90	5-6 tons	MD	CLRRI	2004
	OM 6976	95-100	Winter-Spring: 7 – 9 tons Sumer-Autumn: 5-6 tons	MD	CLRRI	2010

Appendix A1 (Continued)

Group	Varieties	Duration (days)	Average yield (tons)	Target area for growing	Source of parental line	Year of release
	OM 6162	95-100	Winter-Spring: 6 – 8 tons Sumer-Autumn: 4-6 tons	MD	CLRRI	2010
	OM 6600	90-95	6-8 tons	MD	CLRRI	2011
	OM 3673	90-95	7-9 tons	MD	CLRRI	2009
	OM 2517	90-95	5-8 tons	MD	CLRRI	2004
	IR 4625	90-110	5-6 tons	MD	CLRRI	2009
Low quality rice	IR 50404	85-90	7-9 tons	MD	VAAS	1992

Note: CLRRI: Cuu Long Rice Research Institute

VAAS: Vietnam Academy of Agricultural and Science

DARDST : Department of Agricultural and Rural Development Soc Trang

Source: MARD (2012)

Appendix A2 Vietnam standards of white rice for export (TCVN 5644-2008)

Types	% volume	The rate of Components of rice									Quality standard (% max)						Milling degree
		Long kernels, L > 7,0 mm	Short kernels L < 6,0 mm	Unbroken (%)	Average length of kernels (mm)	Broken (%)	Small broken (%)	Red & red streaked (% max)	Yellow kernels (% max)	Chalky kernel (% max)	Damaged (% max)	Glutinous kernels (% max)	Immature kernels (% max)	Foreign matter (% max)	Paddy (grain / kg max)	Moistures (% max)	
Long grain rice	100% A type	≥ 10	≤ 10	> 60	(0,5-0,8) L	< 4,0	≤ 0,1	0,25	0,2	5	0,25	1,5	0	0,05	10	14,0	well milled & polished
	100% B type	≥ 10	≤10	≥ 60	(0,5- 0,8) L	< 4,5	≤ 0.1	0,5	0,2	5	0,50	1,5	0	0,05	10	14,0	well milled & polished
	5%	≥ 5	≤ 15	≥ 60	(0,35 - 0,75) L	5,0 ±2	≤ 0,2	2	0,50	6	1,0	1,5	0,2	0,1	15	14,0	well milled & polished
	10%	≥ 5	≤ 15	≥ 55	(0,35 - 0,7) L	10 + 2	≤ 0,3	2	1,00	7	1,25	1,5	0,2	0,2	20	14.0	well milled & polished
	15%	-	< 30	≥ 50	(0,35 - 0,65) L	15 ± 2	≤ 0,5	5,00	1,25	7	1,50	2,0	0,3	0,2	25	14,0	well milled
	20%	-	< 50	≥ 45	(0,25 - 0,60) L	20 ± 2	≤ 0,1	5,00	1,25	7	2,00	2,0	0,5	0,3	25	14,5	well milled
	25%	-	< 50	≥ 40	(0,25-0.5) L	25 ± 2	≤ 0,2	7,00	1,50	8	2,00	2,0	1,5	0,5	30	14,5	well milled

Appendix A2 (Continued)

Types	The rate of				Components of rice						Quality standard (% max)						Milling degree
	% volume	Long kernels, L > 7,0 mm	Short kernels L < 6,0 mm	Unbroken (%)	Average length of kernels (mm)	Broken (%)	Small broken (%)	red & red streaked (% max)	yellow kernels (% max)	chalky kernel (% max)	damaged (% max)	glutinous kernels (% max)	immature kernels (% max)	foreign matter (% max)	paddy (grain / kg max)	moistures (% max)	
Short grain rice	45%	- - -	< 50	≥ 28	(0,25-0.5) L	45 ± 2	≤ 0,3	7,00	2,0	10	2,50	2,0	2,0	0,5	30	14,5	reasonably well milled
	5%		> 75	≥ 60	(0,35-0,75) L	5 ± 2	≤ 0,2	2,0	0,5	6	1,0	1,5	0,2	0,1	15	14,0	well milled & polished
	10%		> 75	≥ 55	(0,35-0,7) L	10 ± 2	≤ 0,3	2,0	1,00	7	1,25	1,5	0,2	0,2	20	14,0	well milled & polished
	15%		> 70	≥ 50	(0,35-0,65) L	15 ± 2	≤ 0,5	5,0	1,25	7	1,50	2,0	0,3	0,2	25	14,0	well milled
	20%		> 70	≥ 45	(0,25-0,60) L	20 ± 2	≤ 0,1	5,00	1,25	7	2,00	2,0	0,5	0,3	25	14,5	well milled
	25%		> 70	≥ 40	(0,25-0,5) L	25 ± 2	≤ 0,2	7,00	1,50	8	2,00	2,0	1,5	0,5	30	14,5	reasonably well milled
	35%		> 70	≥ 32	(0.25- 0,5) L	35 ± 2	≤ 0,2	7,00	2,0	10	2,00	2,0	2,0	0,5	30	14,5	reasonably well milled
	45%		> 70	≥ 28	(0.25-0,5) L	45 ± 2	≤ 0,3	7,00	2,0	10	2,50	2,0	2,0	0,5	30	14,5	reasonably well milled

Source: Vietnam standard (1999)

Appendix B

Willingness to Accept to Aromatic Rice in the Mekong Delta

Appendix B1 Linear regression model for willingness to grow aromatic rice (opened-ended question)

Variables	Coefficient estimates (α)	Mean of z_j	$\alpha * z_j$
Number of extensions	-14.0888	4.3667	-61.5212
D_ Can Tho	-139.2076	0.5667	-78.8843
Buy seed from private company	181.8971	0.3167	57.6008
D_ Sell rice at home	215.4793	0.2000	43.0959
D_ Sell all rice	317.7713	0.7167	227.7361
D_ Alluvial soil	-180.8729	0.7833	-141.6838
D_ Salty soil	-454.9818	0.0500	-22.7491
D_ Member	299.8535	0.1167	34.9829
Cons	908.0893	-	-
Mean of WTA	966.6665		

Appendix C

Questionnaire

QUESTIONNAIRE

Questionnaire's number:

Name of interviewer: …… …… Date of the interview:……..

Name of farmer: …… Gender: .....

Village: ……..... Commune: ……..……

District: …… Province: ……..……

Ethnicity…… Mobile number of farmers: ……..

A. BACKGROUND INFORMATION

1. Who make decision in rice production in your family?

□ ***Wife*** □ ***Husband*** □ ***Your son***

a. Age of decision maker: .....
b. Education level.....
c. Qualification (if have): .....

2. Main job

Farmer □ Other job □ Specify your job: …….……

3. Information of other members in your family?

a. Number of family member: Male: ..…….. Female: …….

b. Number of people who directly growing rice: ……

B. INFORMATION ABOUT RICE PRODUCTION AND CONSUMPTION OF LAST YEAR (FIRST PLOT)

Plots (area m^2)	Information about rice production							Information about consumption				
	Crop	Renting fee	Soil types *	Varie-ties	Maturing time (from planting to harvesting) (days)	Source of seeds **	Yeild (gia/cong) (1gia=20kg; 1 cong= 000m^2)	Consume (%)	Sell (%)	Price of rice varieties (VND/kg)	Sell to ***	Sell at ****
1 …….. m^2 Irrig-ation ***** ……	*Winter - Spring season* 2013											
	Summer - Autunm season 2013											
	Autunm - Winter season 2012											

** 1 soft alluvial soil, 2 soft coastal soild, 3 Soil acidification, 4 Other (fill in the blank);*

*** 1 Buy from seed producing company, 2 Local seed producing group, 3 Producing seed by your own, 4 Local agricultural office 5 Extension station 6 neighbour 7 Other (fill in the blank)*

**** 1 sell to local rice merchant , 2 sell to production group, 3 sell to rice exporting company, 4 Others(Fill in the blank);*

***** 1 sell at field, 2 sell at home, 3 sell at the place of rice purchase, 4 Other (fill in the blank);*

****** 1: Can control water for rice production (have dyke and pump to prevent water from local river and sea) ; 2: depend completely on season and tide from the sea)*

B. INFORMATION ABOUT RICE PRODUCTION AND CONSUMPTION (SECOND PLOT)

Plots (area m^2)	Information about rice production							Information about market				
	Crop	Renting fee	Soil types *	Varieties	Maturing time (from planting to harvesting) (days)	Source of seeds **	Yield (gia/cong) (1gia = 20kg; 1 cong = 1000m^2)	Cons-ume (%)	Sell (%)	Price of rice varieties (VND/kg)	Sell to ***	Sell at ****
2 …… ….. m^2 Irrigation ***** …… ……	*Winter – Spring season* 2013			-								
	Summer – Autunm season 2013			-								
	Autunm - Winter season 2012			-								

** 1 soft alluvial soil, 2 soft coastal soild, 3 Soil acidification, 4 Other (fill in the blank);*

*** 1 Buy from seed producing company, 2 Local seed producing group, 3 Producing seed by your own, 4 Local agricultural office 5 Extension station 6 neighbor 7 Other (fill in the blank)*

**** 1 sell to local rice merchant , 2 sell to production group, 3 sell to rice exporting company, 4 Others(Fill in the blank);*

***** 1 sell at field, 2 sell at home, 3 sell at the place of rice purchase, 4 Other (fill in the blank);*

****** 1: Can control water for rice production (have dyke and pump to prevent water from local river and sea) ; 2: depend completely on season and tide from the sea)*

C. KNOWLEDGE AND PERCEPTION ABOUT AROMATIC RICE PRODUCTION

1. Do you know aromatic rice? (if not give them the definition of aromatic rice and some examples about aromatic rice varieties then skip to No6)
2. How long have you been growing rice? .....
3. How long have you been growing aromatic rice? …..……..
4. Since the first time you grow aromatic rice, have you ever stop growing aromatic rice and how long did you stop?.....
5. Reason why you stop: ……
6. Area of each rice varieties in your field in each crop

Crop	Aromatic rice	Non-aromatic rice
Winter - Spring		
Summer - Autumn		
Autumn - Winter		

7. Can you tell some aromatic rice varieties that you know?

Aromatic rice varieties	Yes, I know	Specify characteristic (advantage and disadvantages of that varieties: suitable with which season for example, it it suitable with your local area)
1. Tai Nguyen		
2. Nang Thom Cho Dao		
3. Nang Thom Muon		
4. KhaoDak Mali		
5. Jasmine 85		
6. ……		

8. Compare difficulties between the aromatic rice production (the most popular aromatic rice variety: Jasmine 85) and non-aromatic rice production (the most popular non-aromatic rice variety: OM50404)

	Maturing time	**Resistant to pets**	**Fertilizer cost**	**Pesticide cost**	**Labor cost**	**Amount of seed per area (kg/cong or kg/1000m^2)**
Higher (How much higher)						
Equal						
Less (How much less)						

9. Compare difficulties between the aromatic rice (Jasmine 85) and non-aromatic rice production (IR 50404) in term of market?

	Easy to sell	**Price**	**Uncertainty of price**	**Easy to have contract with rice exporting company**	**Other (please specify)**
Higher (1)					
Equal (2)					
Less (3)					

10. Supporting for aromatic rice production?

Have you received any support or advice in producing aromatic rice from local company? □ *Yes* □ *No*

If have, please tell clearly how they support: ……

C. EXTENSION

1. Where do you have information about aromatic rice?

Sign X in the choice and please explain clearly the way you have information form that information sources.

Source of information	**Information about aromatic rice production (varieties, rice production techniques)**		**Information about market (price, demand, new rice policies of government, government's support in rice production)**	
	Yes	**How you get information**	**Yes**	**How you get information**
Television				
Radio				
Newspaper				
Members of the group that you join in				
Neighbor				
Extension office				
Seed company				
Inputs company (fertilizer, pesticide)				
Extension officer				
Others				

2. Times of contacting with extension services last year?

Main topic	Times
- Techniques to growing new rice varieties	
- Pest management	
- Techniques to produce seed	
- Other……..	

3. Which group you are belonging to? (can chose more than 1)

- *Agricultural Co – operative*
- *Seed producing group*
- *Good agriculture practice (global gap, Vietgap)*
- *Not belong to any group*

4. Have you ever participated in demonstration of growing new rice varieties?

Yes ( ) *No ( )*

Year of demonstration: ……..……..

Who support for this rice demonstration: ……..

Area of demonstration: ……..……

Rice varieties that you grow in this demonstration: ……

5. Do you know any farmer in your local area that grew aromatic rice?

Does it suit with soil characteristic of your local area?

Yes □ No □

Explain why: …… ……

6. Training course that you and your family members joined this year?

Name/ contend of the training course	**Helpful or not**		**Note**
	Yes	No	

7. Information that you expect to know from extension?

Knowledge/ information	**Do you need**		**Do you satisfy with information that giving by local extensionist?**	
	Yes	No	Yes	No
Choosing varieties to grow with your soil characteristic				
Pest management				
Demand market and price forecast				
Information about input price				
Source of rice seeds				
Others				

8. Do you have contract with company?

Yes □ No □

9. Ranking the importance of these factors in your decision of growing aromatic rice from 1 to 5?

Factors	**Score (1, 2, 3, 4, 5)**
Higher price than normal rice	
Bandwagon (producing the same varieties with others farmer in the same commune); (* Rice farmer in Mekong delta often produced according to the majority, use the same varieties with their neighbor to be easy to sell, because the rice collectors don't buy a small amount of rice)	
Maturing time of aromatic rice varieties is longer than normal rice	
Irrigation for aromatic rice is less than normal rice varieties	
Willing to take a risk of trying new varieties	

10. If the different price between aromatic rice (Jasmine 85) and non-aromatic rice (IR 50404) is 300vnd/ 500 nvd/ 700 vnd/ 1000 vnd will you swift to growing aromatic rice (Jasmine 85)? (*Note: the interviewer randomly chose one of above bid prices to ask farmers (IR 50404 growers), farmers will chose agree or not agree to swift to growing aromatic rice (Jasmine 85) with that bid price.

Yes □ No □

11. How much different between IR 50404 rice price and Jasmine 85 rice that makes you swift from growing IR 50404 rice to growing Jasmine 85 aromatic rice (ask only IR 50404 growers)? …….. VND.

12. Do you have any recommendations about aromatic rice development in your local area?

(1) Recommendations about price and market?

……

……

(2) Recommendations about production and varieties?

……

……

3. Other recommendations?

……

……

……

THANK YOU SO MUCH FOR YOUR INFORMATION!

CURRICULUM VITAE

NAME : Ms. Tran Hoai Thao Trang

BIRTH DATE : November 19, 1988

BIRTH PLACE : Buon Me Thuot, Vietnam

EDUCATION : **YEAR** **INSTITUTE** **DEGREE/DIPLOMA**

2010	Vietnam National University of Agriculture	B.Sc. (Agricultural Economics)

POSITION/TITLE : Researcher

WORK PLACE : Institute of Economics and Development
Hanoi University of Agriculture
Vietnam

SCHOLARSHIP AWARD: Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA)