UNIVERSITY FOR DEVELOPMENT STUDIES,
TAMALE

ADOPTION OF NERICA AMONG RICE FARMERS IN TOLON AND KUMBUNGU DISTRICTS IN THE NORTHERN REGION OF GHANA

LAMPTEY YAW CLEMENT

2018

UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE

ADOPTION OF NERICA AMONG RICE FARMERS IN TOLON AND KUMBUNGU DISTRICTS IN THE NORTHER REGION OF GHANA

LAMPTEY YAW CLEMENT (BSC, MA)

(UDS/MIC/0039/12)

THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL EXTENSION, RURAL DEVELOPMENT AND GENDER STUDIES, FACULTY OF AGRIBUSINESS AND COMMUNICATION SCIENCES, UNIVERSITY FOR DEVELOPMENTSTUDIES, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN INNOVATION COMMUNICATION

APRIL, 2018

DECLARATION

STUDENT

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this University or elsewhere:

Candidate's Signature: ……Date: ……

Name: **Lamptey Yaw Clement**

SUPERVISORS

I hereby declare that the preparation and presentation of the thesis was supervised in accordance with the guidelines on supervision of thesis laid down by the University for Development Studies.

Principal Supervisor's Signature: …… Date: ..……..

Name: **Dr. Richard W. N. Yeboah**

Co-Supervisor's Signature: ……... Date: ……

Name: **Dr. Wilson Dogbe**

ABSTRACT

New Rice for Africa (NERICA), a hybrid between African rice and high-yielding Asian varieties of *Oriza sativa,* believed to be a magic crop developed in 1994 by WARDA for both upland and lowland cultivation in Africa, was disseminated between 2005 and 2010 by SARI and MoFA to 6,888 rice farmers in the then Tolon/Kumbungu District (now Tolon and Kumbungu Districts) Northern Region, Ghana. The innovation was expected to be adopted by rice farmers in the project area, after 2010. However, the extent to which it was adopted as at 2014 was not determined. This study sought to ascertain the adoption of NERICA in the two districts from 2011 to 2014. Purposive sampling technique was used to obtain a sample of 378 NERICA farmers from 16 NERICA communities for the study. A survey was conducted to obtain both quantitative and qualitative data for the study. Data obtained was analysed using inferential statistics (logistic regression) and descriptive statistics. The study revealed that individual and group extension teaching methods used to disseminate NERICA from 2005 to 2010 to rice farmers in the study area were more appropriate than mass media, due to the nature of the innovation and its potential adopters.

Adoption of NERICA in the study area occurred only in 2011 when the project support was still available to the farmers. Disadoption of NERICA occurred in 2012, 2013 and 2014 respectively. Disadoption is a wilful refusal to adopt an innovation after one has earlier adopted it. The innovation on the other hand was compatible, observable, and less complex with relative advantage, triability and possibility of re-invention. Farmers' educational level, whether they thought NERICA was better than other rice varieties in the study area, household size and primary occupation significantly affected their adoption of NERICA. NERICA innovation is regarded as successful but its adoption in the dissemination area is not successful. The project (NRDP) should be reviewed to encourage NERICA adoption in the study area.

ACKNOWLEDGEMENTS

I give glory to the Most High God for giving me life, wisdom, strength and knowledge, to embark on this study. I wish to acknowledge all individuals, institutions and organizations who have contributed in diverse ways to make this work successful.

My special thanks goes to my supervisor, Dr. Richard W. N. Yeboah, of the Department of Agribusiness Management and Finance, University for Development Studies, Nyankpala, for sparing time of his busy schedules to painstakingly guide me through this work. My special thanks also go to my Co-supervisor, Dr. Wilson Dogbe of Savannah Agricultural Research Institute, Nyankpala, for showing interest in my work and willingly accepting to guide me through this research.

I wish to also acknowledge Mr. Baba Musah, officer in charge of Personnel, Monitoring and Evaluation, Ministry of Food and Agriculture (MoFA), Tolon, and his team of Agricultural Extension Officers who assisted me before, during and after the survey to gather and organize my data. The following AEAs are worth mentioning in this regard: Mr. Musah Shiraz, Mrs. Mbah Ogechi Sylverlin and Mrs. Alima Issahaka all of MoFA, Tolon. The rest are Mrs. Amidatu Adam, Mr. Michael Nodzi and Mr. Baba Alhassan all of MoFA, Kumbungu.

To Mr. Daniel Aduah Wedam of Shalom Chapel International, Tamale, and Mr. Alhassan Yussif, a contact farmer at Gbulung, my interpreters and special assistants during the data collection period, I say thank you! Nii Tuma Pam! May God richly bless you! I am as well indebted to my colleagues especially, Mr. Alhassan Abukari and Mr. Bismarck Amfo all of UDS, for assisting me during the data analysis. My final appreciation goes to Rev. Johnson Asare, Director of Radach Lodge and Conference Centre, for inspiring me to pursue my Masters' Degree in Agriculture.

DEDICATION

This thesis is dedicated to the Almighty God.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ADB/AfDB	African Development Bank
ADRA	Adventist Development and Relief Agency
AEAs	Agricultural Extension Agents
AEZ	Agro Ecological Zone
ARI	African Rice Initiative
ATS	Agricultural Technology Systems
CD-ROM	Compact Disk-Read Only Memory
CPU	Project Coordination Unit
CSRI	Centre for Scientific and Industrial Research
DADU	District Agricultural Development Unit
DDA	District Director/Directorate of Agriculture
ETM	Extension Teaching Methods
FAO	Food and Agricultural Organization
FGDs	Focus Group Discussions
FGs	Focus Groups
GDP	Domestic Gross Product
GR	Growth Rate
GSS	Ghana Statistical Service
IFAD	International Federation for Agricultural Development
MoFA	Ministry of Food and Agriculture
NARI	National African Rice Initiative
NERICA	New Rice for Africa
NGOs	Non-Governmental Organizations
NRDP	Nerica Rice Dissemination Project

OECD	Organization for Economic Co-operation and Development
PVS	Participatory Varietal Selection
RDPs	Rice Development Projects
SARI	Savannah Agricultural Research Institute
SG2000	Sasakawa Global 2000
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
UDS	University for Development Studies
UNDP	United Nations Development Program
USAID	United States Agency for International Development
VCR	Video Cassette Recorder
WARDA	Africa Rice Centre (West Africa Rice Development Agency)
WIAD	Women In Agricultural Development
WVI	World Vision International

WORKING DEFINITION OF TERMS

Adopters of NERICA: Farmers who have cultivated and/ or are cultivating the NERICA varieties after the dissemination period.

Adoption Gap: A lapse in the adoption process. That is, the difference between the population adoption rate and the actual adoption rate.

Adoption Rates: A percentage of the population that has adopted or not adopted the innovation. Thus, an innovation's rate of adoption in a system is usually measured as the number of members of the system who adopt the innovation in a given time period. It also refers to the relative speed with which an innovation is adopted by members of a social system.

Adoption: Acceptance and continuous usage of new Agricultural ideas and technologies. Adoption here refers to the cultivation and use of NERICA by the farmer, after 2010.

Diffusion: A process of innovation imitation or spread of innovations among individuals in a social system. Diffusion can be interpreted as aggregate adoption.

Disadoption: Wilful rejection of an innovation after adopting it earlier.

Innovation: New Agricultural idea or technology introduced to farmers for adoption.

Level of Awareness of the Innovation: The extent to which a farmer is said to be familiar with the new technology introduced to him or her. This includes how and when one became conversant with the innovation.

Levels of Adoption: The extent to which new Agricultural ideas and technologies have been accepted and practiced or used by its intended beneficiaries.

NERICA: New Rice for Africa, the innovation introduced to rice farmers in Tolon and Kumbungu Districts in the Northern Region of Ghana, from years 2005 to 2010.

Non-Adoption of the Innovation: This refers to wilful decline or rejection of the innovation after a farmer became aware or familiar with it.

CHAPTER ONE

INTRODUCTION

1.1. Background to the Study

Rice is one of the staple foods in Ghana used on many occasions such as festivals, funerals, outdoorings, weddings and marriage ceremonies, installation of chiefs and kings and at social gatherings. It is also one of the main food items found on the menu charts of many institutions like prisons, clinics, hospitals, schools, colleges, and universities, and conspicuous on the menu charts of many restaurants, hotels, 'chop bars' and food joints in Ghana (Ministry of Food and Agriculture [MoFA], 2010; http://www.ghanabusinessnews.com). However, much of the rice that is served at these functions is imported. Many Ghanaians have grown to like 'polished' rice, even though it is less nutritious compared to the local rice.

Empirical evidence showed that local rice was mostly patronized in the rural areas and by many people who were considered 'poor' (the urban poor) or who could not afford polished rice. That phenomenon had come to live with us such that *seemingly 'rich' people who patronized 'local rice' were considered as misers who would not like to spend their moneys on 'quality food'.* Such rich people who patronized the local rice normally had a great deal convincing their relations of its nutritional value. Sometimes, it was better for one to say one preferred local rice due to health reasons or based on medical advice.

The irony of the matter was that, we ended up spending much money on imported rice than local rice to the detriment of our health, economy and the welfare of local rice farmers**.** Rice imports into Ghana over the past six years ranged from

384,000MT in 2009 to 414,000MT in 2014 (http://www.ghanabusinessnews.com). In 2014, Ghanaians consumed a total of 754,698 metric tons of rice and imports make up 52 per cent of the figure, but it is be believed that the numbers might be bigger because of smuggling, which is not accounted for (http://www. newsghana.com.gh). Ghana is predominantly an agricultural country with the sector contributing about 30 percent to gross domestic product (Ghana Statistical Service [GSS], 2014). There has been a quest for a very good variety of rice for production so as to reduce the export.

It was for that reason that Ghana participated in and implemented the multinational NERICA Rice Dissemination Project (NRDP), and other similar rice Programmes, to affirm the Government's commitment to revamp the local rice sub sector (MoFA, 2010). The project, which was implemented in Benin, the Gambia, Guinea, Ghana, Mali, Nigeria and Sierra Leone, was supported by several donors, including the Government of Japan, the UNDP, the Rockefeller Foundation, the CFC, USAID, IFAD, SG2000, the FAO, the ADB and the World Bank. African Rice Initiative (ARI) had the mandate for project. ARI's mandate was extended to East and Central African countries for NERICA's dissemination (WARDA, 2003; African Development Bank [AfDB], 2012).

Currently, 66% of rice consumed in Ghana is imported. Only 34% of rice consumed in this country is produced locally, resulting in the importation of 680,000MT annually (https://www.ghanaweb.com) at the cost of $500million dollars per annum (http://citifmonline.com), meaning the objective of reducing rice import into Ghana by the NRDP was not achieved.

The New Rice for Africa (NERICA) was created in 1994 by crossing African rice with high-yield Asian varieties of *Oriza sativa*. The essence was to create rice varieties that would have a blend between 'local' rice and 'polished' rice, hence, 'NERICA'. Prior to the NRDP, farmers were exposed to adopt and consume perfumed rice varieties but yields had not improved as expected. As such, there was scarcity of Ghana made perfumed rice for local consumption. So much money had to be invested in the NRDP by donor agencies and the government of Ghana that it would be a disincentive to Ghana if the project's goals or its gains were short lived.

Since the technology had been disseminated in 2010, it appears no intensive research had been carried out to determine the extent of adoption of the innovation. An evaluation was done a year after the dissemination exercise by Asuming-Brempong, *et al,* (2011), which revealed low levels of adoption in Ghana: the highest being 6% and the least was 1% . Another study by Asante *et al,* (2014) revealed a high adoption rate of 68 per cent among sampled farmers in Ghana. This research aimed at finding out the current adoption rates of the innovation in the Tolon and Kumbungu Districts in the Northern Region of Ghana. Adoption rate in this context refers to the percentage of NERICA farmers that adopted (cultivated) the magic crop in a given year, after the dissemination period.

The prospects of NERICA were such that it should be preferred to both local and polished rice varieties. However, it was not clear whether the farmers preferred the NERICA to the existing varies. According to Bellon (2001), farmers' adoption of rice varieties may differ depending on the positive or negative attributes of the various varieties. That was because the choice of one variety over the others was greatly influenced by the balance between the positive and negative attributes of the

varieties (Bellon, 2001). Since the NERICA was relatively a new technology, it might have taken a while for it to be adopted or diffused into the social system.

Whatever the case or situation, this research would ascertain the extent of adoption of NERICA. The fact is, one should not expect these farmers to have adopted the NERICA hook, line and sinker. The innovation had to go through the decision making process for it to be accepted or rejected. Rogers (2003) described the innovation-decision process as an information-seeking and information-processing activity, where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation. So at any stage of the adoption and diffusion process, the innovation would be subjected to the full length of the decision-making process either by an individual or a unit of adoption.

1.2. Research Problem

The NERICA varieties were disseminated to rice farmers in the Tolon and Kumbungu Districts from 2005 to 2010, to increase sustainability and food security as well as reduce the importation of rice into the country (MoFA, 2010; AfDB, 2012). Unlike other Agricultural innovations that were mainly disseminated by the Agricultural Extension Agents (AEAs) of the Ministry of Food and Agriculture (MoFA), the dissemination of NERICA to farmers in the Tolon and Kumbungu Districts was a joint venture between MoFA and Savannah Agricultural Research Institute (SARI), and financed by the African Development Bank (MoFA, 2010; AfDB, 2012). Despite the huge investments made and clear objectives of the project, the innovation does not appear to have been adopted by the farmers. Assuming-Brempong *et al,* (2011) revealed only 1% level of awareness and adoption of the

innovation. They projected the potential adoption rate of 91% and actual adoption rate of about 47% in the near future. However, no adoption study has been carried out on the innovation four years after the work of Assuming-Brempong *et al*, (2011) to determine the actual and potential adoption rates of NERICA in the study area.

Rogers (2003), posits that time plays a significant role in the adoption and diffusion processes of an innovation, hence it is important to conduct an adoption study after about 4 years of the introduction of the NRDP innovation. That is because it was believed that the adoption rates would increase with time.

1.3. Main Research Question

The main research question of this thesis is to look at the adoption of NERICA among rice farmer in the Tolon and Kumbungu Districts in the Northern Region of Ghana.

1.3.1. Specific Research Questions

Specific research questions are asked to help arrive at answers to the main research question. These are:

1. Which innovation dissemination methods were used to introduce NERICA to rice farmers in the Tolon and Kumbungu Districts?
2. What were the specific adoption rates of NERICA in the 2 districts?
3. What factors affected adoption of the NERICA innovation among the rice farmers in the districts?
4. What are the challenges and prospects of NERICA adoption in the 2 districts?

1.4. Main Objective

The main Objective of the research is to study the factors affecting the adoption of NERICA among rice farmers in the Tolon and Kumbungu Districts in the Northern Region of Ghana to help determine the adoption rates and suggest policy recommendations.

1.4.1. Specific objectives

The specific objectives that this study seeks to address are to:

1. Find out the methods used to disseminate NERICA to farmers in the districts.
2. Determine the adoption rates of NERICA in the districts.
3. Analyse the factors affecting adoption of the innovation among the rice farmers in the districts.
4. Examine the challenges and prospects of NERICA adoption in the 2 districts.

1.5. Scope of Study

Geographically, the study area was Tolon and Kumbungu Districts in the Northern Region of Ghana. The study concentrated on the period between 2005 and 2014. The reason being that the innovation was disseminated from 2005 to 2010 and it was expected to diffuse within the district and beyond, after the dissemination period.

This study was limited to only one of the ten districts in Ghana where the NERICA varieties were introduced. The chosen district was Tolon-Kumbungu District (now, Tolon and Kumbungu Districts). The study concentrated on only rice producers in the districts, and not on all crop farmers, with particular emphasis on beneficiaries of the NRDP. A sample survey rather than a census was conducted to elicit responses from rice farmers in the study area.

1.6. Justification of the Study

The study would reveal the suitability of the extension communication methods used to introduce NERICA to rice farmers in the study area. It would show the adoption rates of NERICA in the study area and also bring to the fore factors that affected the adoption of the innovation as well as the challenges and prospects of NERICA adoption in the two districts.

Four years after the dissemination period, was a good time to ascertain whether the innovation had actually been adopted or rejected by the farmers. If adopted, the adoption needed to be verified and documented. If rejected, the reasons for the rejection also needed to be known to help advice policy makers and researchers on future agricultural innovations to rice farmers. It might also be that the innovation was only adopted by the beneficiaries of the NRDP or its diffusion ended with exit of the dissemination project. Whichever way, this study would reveal and address the facts.

This research would therefore contribute significantly to knowledge in the field of agricultural Innovation Communication. It would also inform policy makers to provide appropriate legislation for the dissemination of Agricultural innovations in this country as well as provide a platform for further research on NERICA diffusion and adoption.

1.7. Limitations and Delimitations

Time, material and financial constraints hindered the scope, progress and speed of this research since the researcher combined full-time teaching job with the research

work so as to finance the study, which was stressful. Language was another barrier to smooth communication with farmers in the data collection process. To address this, the services of interpreters were employed in the data collection. Transportation difficulties due to poor road network also affected the study coverage, since some communities were 'overseas' areas during the raining season. Since most of the farmers did either mixed farming or mixed cropping, it was difficult to isolate farmers who cultivated only NERICA.

Since the Tolon-Kumbungu District became a split district, the study could not cover equal number of beneficiaries of the NRDP in each district. Though there were eight operational areas in each district, the number of beneficiary farmers in the Tolon district doubled those in the Kumbungu district. So two thirds of the sampled farmers were taken from the Tolon District. The project treated the beneficiary farmers as members of one district (before, during and after the dissemination period). Some respondents and available literature on the project therefore referred to the two districts as Tolon-Kumbungu District. For example, profile of the split districts was not available in the district assemblies until October 2014 (GSS, 2013).

Data collection was also scheduled for the dry season so as to circumvent the problem of transportation to unmotorable areas during the rainy season. The study focused on only beneficiaries of the NRDP because results from the preliminary survey revealed that no new farmers cultivated NERICA after the project ended. Finally, since the Tolon-Kumbungu District became a split district, the study considered the beneficiaries of the NRDP as members of two districts instead of one district, so as to avoid bias in the data collection process and to ensure accuracy and

reliability of the primary data. However, the data was not separated because the two districts were homogenous.

1.8. Organization of the Study

The write up of this study is organised into five chapters. The first chapter gives the background of the study. It also states the research problem, research questions to be answered, the objectives of the study and justification of the study. In the second chapter, relevant literature on the issues under consideration were reviewed and reported. The third chapter provides the general information of the study area relevant to the study and methodology adopted for the study and how it was used. The fourth chapter contains details of the main findings and discussions of the research. Here, findings addressing the research questions are discussed under the topics of innovation dissemination methods used to introduce NERICA to rice farmers in the Tolon and Kumbungu Districts, extent of adoption of NERICA in the two districts, factors that affected adoption of NERICA in the two districts, and the NERICA variety adopted most by farmers in the study area. In chapter five, a summary of the findings and conclusions drawn from the study as well as recommendations were made for further studies on the project.

CHAPTER TWO

LITERATURE REVIEW

2.1. Theoretical Framework

Literature was reviewed on the concept of innovation, diffusion of innovations, the four main elements in the diffusion of innovations, adopter categories, and rates of adoption of innovations. It also looked at agricultural innovations, the role of Agricultural Science in agricultural innovations, generation of innovations, development and dissemination of agricultural innovations. It further discussed adoption and diffusion of agricultural innovations, the innovation-decision process, factors effecting adoption and non-adoption of agricultural innovations; and challenges to diffusion and adoption of agricultural innovations, as well as attributes of rice varieties that enhance their adoptability by farmers.

2.1.1. The Concept of Innovation

The Organization for Economic Co-operation and Development (OECD) regards an innovation as any knowledge (new or existing) introduced into and used in an economically or socially relevant process. The term innovation includes not only the adoption of a new production technology by a smallholder but also a range of other processes, such as the reorganization of marketing strategies by a group of smallholders, the use of new processing technique by an agro-industrial company (Sielman, Davis, Negash, and Ayele, 2008, In: Atigah, 2010). Simply put, the term innovation is an idea or a concept perceived as new by an individual or a unit of adoption in any field of endeavour.

Innovation is also seen as an emergent property of multi-stakeholder interaction; it works only when the actors involved realise that they are interdependent. The actors, be it individuals, enterprises or organizations need to be guided by rules and a framework of conditions to shape their interactions (Braak, 2001). That means that when the actors do not see themselves as partners, the innovation would not work due to ineffective interactions. The innovation system looks at the value chain and employs an inclusive multi-stakeholder partnership approach to diagnose problems and design solutions that convert technologies and institutional changes to innovations. That way, it brings researchers into partnership with Agricultural Extension Agents (AEAs), farmers, input dealers, policy makers, private sector and end users to realize the innovation process. Such an approach shortens the traditional lag between the development of technologies and their adoption thereby improving the chances of development impacts (Braak, 2001). Innovations, when adopted, are supposed to diffuse in the social system.

2.1.2. Diffusion of Innovations

Diffusion is the process in which an innovation is communicated through certain channels over time among the members of a social system. It is a type of communication, in that the messages are concerned with new ideas. The newness of the idea in the message gives diffusion its special character. It therefore means that some degree of uncertainty is involved in diffusion (Rogers, 2003). Hence, there are different categories of adopters based on the perceived risk component and the individual's ability to take such risks (Yoko, 2008).

2.1.3. The Four Main Elements in the Diffusion of Innovations

There are four main elements involved in the diffusion process. They are the innovation, communication channels, time, and the social system. These elements are identifiable in every diffusion research study and in every diffusion campaign or programme (Rogers, 2003; Braak, 2001). Let us look at each of them in detail:

(a) Innovation

Innovation is the idea, practice or object that is perceived as new by an individual or a unit of adoption. Innovations that are perceived by individuals as having greater relative advantage, compatibility, trialability, and observability and less complexity (with the possibility of re-invention) will be adopted more rapidly than other innovations (Rogers, 2003; Braak, 2001). For Rogers (2003), an innovation may have been invented a long time ago, but if individuals perceive it as new, then it may still be an innovation for them. The newness characteristic of an adoption is more related to the three steps (knowledge, persuasion, and decision) of the innovation-decision process that will be discussed later.

Uncertainty is an important obstacle to the adoption of innovations. An innovation's consequences may create uncertainty: *Consequences* are the changes that occur in an individual or a social system as a result of the adoption or rejection of an innovation (Rogers, 2003; Braak, 2001). To reduce the uncertainty of adopting the innovation, individuals should be informed about its advantages and disadvantages to make them aware of all its consequences. Moreover, Rogers (2003) claims that consequences can be classified as desirable versus undesirable (functional or dysfunctional), direct

versus indirect (immediate result or result of the immediate result), and anticipated versus unanticipated (recognized and intended or not).

(b) Communication Channels

The communication channel is the means by which messages get from one individual to another in the social system. Communication therefore becomes the process of sharing information, ideas or messages from a source through a channel to a receiver and vice versa. For Rogers (2003), communication is a process in which participants create and share information with one another in order to reach a mutual understanding. This communication occurs through channels between sources. These channels include telephone, television, radio, computers, internet, newsletters, magazines, leaflets, bulletins, journals, person to person contacts and community fora. Person to person contacts and community fora are more appropriate to farmars because they afford participants the opportunity to clarify the messages they receive on the spot and accordingly give appropriate feedbacks. Person to person contacts and community fora are also considered more credible and trustworthy communication channels because the farmers can easily relate and identify with such channels than the sophiscated ones like internets and magazines.

(c) Time

According to Rogers (2003), the time aspect is ignored in most behavioural research. He argues that including the time dimension in diffusion research illustrates one of its strengths. The innovation-diffusion process, adopter categorization, and rate of adoptions all include a time dimension. The time dimension involved in the diffusion of innovation measures;

1. The innovation-decision process by which an individual passes from first knowledge of an innovation through its adoption or rejection.
2. The innovativeness of an individual or other unit of adoption compared with other members of a system.
3. An innovation's rate of adoption in a system, which is usually measured as the number of members of the system who adopt the innovation in a given time period (Rogers, 2003).

(d) Social System

The social system is the last element in the diffusion process. A social system is a set of interrelated units that collaborate in joint problem solving to achieve a common goal or objective. The members or units of a social system may be individuals, informal groups, organizations, and/or subsystems. It also includes institutions. That defines the social system as a set of interrelated units engaged in joint problem solving to accomplish a common goal (Rogers, 2003).

2.1.4. Adopter Categories

Rogers (2003) defined the adopter categories as the classifications of members of a social system on the basis of innovativeness. This classification includes innovators, early adopters, early majority, late majority, and laggards. In each adopter category, individuals are similar in terms of their innovativeness. Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system (Rogers, 2003; Braak, 2001). Innovativeness can also be considered as a relatively-stable, socially-constructed, innovation-dependent characteristic that indicates an individual's willingness to change his or

her familiar practices (Braak, 2001). Rogers (2003) categorizes the adopters based on innovativeness as Figure 2.1 shows.

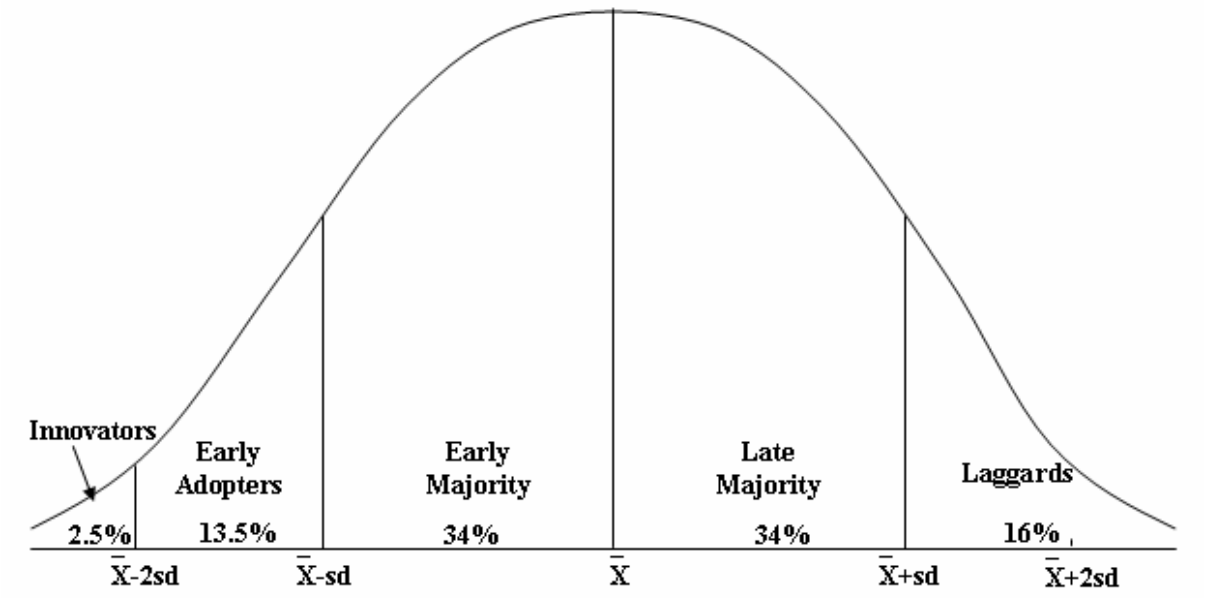

Figure 2.1: Adopter Categorization on the Basis of Innovativeness
Source: Rogers, 2003

Rogers (2003) also noted that incomplete adoption and non-adoption do not form this adopter classification. Only adopters of successful innovations generate this curve over time. In this normal distribution, each category is defined using a standardized percentage of respondents. For instance, the area lying under the left side of the curve and two standard deviations below the mean includes innovators who adopt an innovation as the first 2.5% of the individuals in a system (Braak, 2001; Rogers, 2003).

For Rogers (2003), *innovators* are more willing to experience new ideas than other members of the social system. Compared to innovators, *early adopters* are more limited with the boundaries of the social system. Rogers (2003) argued that since early adopters are more likely to hold leadership roles in the social system, other members come to them to get advice or information about the innovation. In fact,

leaders play a central role at virtually every stage of the innovation process, from initiation to implementation; particularly in deploying the resources that carry innovation forward (Braak, 2001; Light, 1998). Innovators and early adopters therefore tend to lead the *early majority, late majority and laggards* in the adoption of innovations.

Laggards, unlike the others, tend to decide after looking at whether the innovation is successfully adopted by other members of the social system in the past. Due to these characteristics, laggards' innovation-decision period is relatively long (Hasin, 2006). However, according to Morris and Doss, (1999) adoption of agricultural innovations is highly correlated with the number of adult men in the farmer's household. The findings of Morris and Doss (1999) contradict the assertion of Rogers (2003) in the sense that "adults" (in the Ghanaian context) are people above age 18 years who have the needed resources and propensity to adopt innovations. The aged (people above 60 years) tend to be slow in adopting innovations (Rogers, 2003; GSS 2013) because they do not like to take high risks. Younger people (say those below 18 years) are daring but do not have the needed resources to enable them adopt innovations like the middle age adults do. For Rogers (2003), there is no significant difference between early adopters and late adopters.

2.1.5. Development and Dissemination of Agricultural Innovations

Agricultural innovations are developed by researchers and communicated to farmers through Agricultural Extension Agents, using various methods and materials (print and non-print). The various methods, materials, tools, strategies and style used by extension practitioners to create situations in which communication can take place

between rural people and extension agents are referred to as Extension Teaching Methods (ETMs) (Rathod, 2016).

Extension methods of disseminating Agricultural innovations include farm and home visits, result demonstrations, method demonstrations, frontline demonstrations, group discussions, exhibitions, general meetings, campaigns, conducted tours, printed matter (literature), radio, television, motion pictures (movies), agricultural clinic, flag method, peripatic team visits, agricultural games , snake and ladder games (Ministry of Food and Agriculture [MoFA], 2011; Indian Council of Agricultural Research [ICAR], 2006; Cole 1981).

ETMs can be classified into two broad categories: (1) by the natures of contacts or usage and, (2) by the form it takes. By the nature of contact or usage, ETMs are grouped into individual contacts, group contacts and mass contacts/media (Cole, 1981; ICAR, 2006; Rathod, 2016), as shown below:

Table 2.1: Classification of Extension Teaching Methods by Nature of Contacts

Individual Contacts/Usage	**Group Contacts/Usage**	**Mass Contacts/Media/Usage**
Farm and Home Visits	Method Demonstrations	News Stories/Newsletters
Result Demonstrations	Meetings/Discussions	Telephone Messages
Personal Correspondence	Leaders' Trainings	Publications/Journals
Telephone Calls	Community Fora	Television/Radio/Internet
Office Visits	Conducted Tours	Answering Systems
Counselling	Field Days/Symposia	Satellite Programmes
	Camps/Clinics/Contests	Exhibitions and Leaflets
	Workshops/Seminars	Interactive Conferences
	Short Courses/Interviews	Posters/Circulars/Bulletins
	Organized Clubs/Debates	Computer Aided Interactive Learning

Source: Author's Construct, 2015

These three teaching methods are further classified as direct contacts (individual and groups contacts) and indirect contacts (mass media/contact). The indirect contacts do not work in isolation. Rather, they stimulate the need for direct contact in the target audience to seek further clarification from extension officers in the dissemination process.

The form could be written (bulletins, leaflets, news articles, personal letters, circular letters, booklets and pamphlets) or spoken (general and special meetings, conferences, farm and home visits, official calls and radio). The form could also be visual/objective (demonstrations, exhibitions, charts, motion pictures, or movies, photographs, slides, film strips, models and specimens) or audio visual (television, meetings at the visual meetings site of demonstrations, involving motion pictures, charts and sound movies, radio vision, other visual material, drama, VCR, sound synchronized slides, internet, and CD-ROM) (ICAR, 2006; Rathod, 2016). The audio visuals can further be classified into audio, visual and audio-visual, as shown in Table 2.2:

Table 2.2: Classification of Audio Visual Extension Teaching Aids

Audio	**Visual**	**Audio-visual**
Tape recorder	Flash cards	Cinema projector
Radio	Black board	Television
Recording	Pictures	Drama

Source: Rathod, 2016

The audio-visual can also be categorised into projected audio visuals (cinema, slide projector, opaque projector and overhead projector) and non projected audio visuals (flashcards, funnel graphs, charts, pictures, blackboards, bulletin boards, models, pictures, posters, specimens, exhibits, photographs) (Prakashkumar, 2016).

A combination of methods such as written and spoken or visual and audio-visual is an effective way of dissemination of agricultural innovations. For example, a film show can be followed by a discussion with farmers or farm families. Obeng (2013) classifies videos as projected visual aids used by extension officers in educating farmers.

Projected visual aids are capable of translating abstract ideas into more realistic formats to farmers and therefore stimulate creative expression in their audience. They also allow instructions to move from the level of verbal symbols to a more concrete level for easy comprehension by farmers. That makes them suitable for attracting larger audience and sustaining their interests in extension training programmes.

Obeng (2013) posits that visual aids (posters, charts, flannel graph, graph, flash cards, puppets, slides, film strip, models, real objects, bulletin boards, mock-ups, photographs, chalk/marker boards, folk songs, and dramas) are suitable means of interacting with both literate and illiterate farmers because they are more appealing, attractive, interactive and entertaining.

There are also new communication technologies that help in teaching or disseminating information to farmers. They include micro-computers, video texts, electronic mails, interactive videos, and teleconferencing (ICAR, 2006; Rathod, 2016). Such materials and means of education are more suitable for educated and sophisticated farmers. The choice of ETMs and materials to be used would therefore

depend on the nature of the target audience, purpose of the education, time and other resources available for the training.

2.1.6. Adoption and Diffusion of Agricultural Innovations

Sunding and Zilberman (2000) posit that there is often a significant interval between the time an innovation is developed and available in the market, and the time it is widely used by producers. Adoption and diffusion are the processes governing the utilization of innovations. They said studies of adoption behaviour emphasize factors that affect if and when a particular individual will begin using an innovation. That means measures of adoption may indicate both the timing and extent of new technology utilization by individuals.

Adoption behaviour may be depicted by more than one variable. It may be depicted by a discrete choice, whether or not to utilize an innovation, or by a continuous variable that indicates to what extent a divisible innovation is used. Diffusion can be interpreted as aggregate adoption.

Diffusion studies depict an innovation that penetrates its potential market. As with adoption, there may be several indicators of diffusion of a specific technology (Sunding and Zilberman, 2000). For example, one measure of diffusion may be the percentage of the farming population that adopts new innovations. Another is the land share in total land on which innovations can be utilized. These two indicators of diffusion may well convey a different picture. In developing countries, 25 percent of farmers may own or use a tractor on their land. Yet, on large farms, tractors will be used on about 90 percent of the land. While it is helpful to use the term “adoption” in

depicting individual behaviour towards a new innovation and "diffusion" in depicting aggregate behaviour, in cases of divisible technology, some economists tend to distinguish between intra-firm and inter-firm diffusion (Sunding and Zilberman, 2000). Diffusion can therefore be regarded as a process of innovation imitation or spread of innovations among individuals in a social system. The process is successive and continuous.

2.1.7. The Innovation-Decision Process

Rogers (2003) describes the innovation-decision process as an information-seeking and information-processing activity, where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation. For Rogers (2003), the innovation-decision process involves five steps: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation. These stages typically follow each other in a time-ordered manner as shown in Figure 2.2:

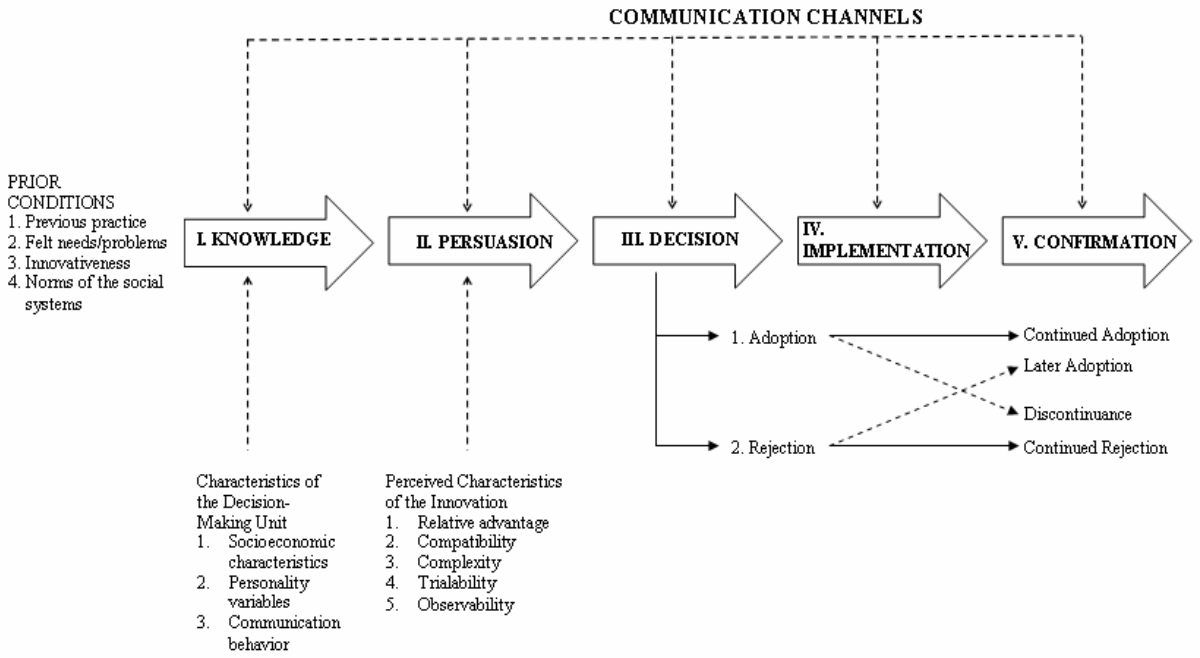

Figure 2.2: A Model of Five Stages in the Innovation-Decision Process
Source: Rogers, 2003

Knowledge Stage: This the stage at which the individual becomes aware of the innovation, how to use the innovation, and the functioning principles describing how and why an innovation works.

The Persuasion Stage: This is the stage where individual becomes persuaded about the innovation and forms either a negative or positive attitude toward it. Rogers, 2003, posited that the formation of a favourable or unfavourable attitude toward an innovation does not always lead directly or indirectly to an adoption or rejection. That is because the individual shapes his or her attitude after he or she knows about the innovation. So the persuasion stage follows the knowledge stage in the innovation-decision process.

The Decision Stage: At the decision stage in the innovation-decision process, the individual chooses to adopt or reject the innovation. While adoption refers to full use of an innovation as the best course of action available, rejection means not adopting an innovation (Rogers, 2003). However, rejection is possible in every stage of the innovation-decision process. The implementation stage follows the decision stage.

The Implementation Stage: At the implementation stage, an innovation is put into practice, though with a certain degree of uncertainty about its outcomes. Hence, the implementer may need technical assistance from change agents and others to reduce the degree of uncertainty about the consequences (Rogers, 2003; Braak, 2001). Reinvention usually happens at the implementation stage, so it is an important part of this stage. Reinforcement is necessary at this stage to enhance confirmation of the decision.

The Confirmation Stage: This is when innovation-decision has been made, and the individual looks for support for his or her decision. According to Rogers (2003), this decision can be reversed if the individual is exposed to conflicting messages about

the innovation. To stick to the decision, the individual has to stay away from these conflicting messages and seek supportive messages that confirm his or her decision. Thus, attitudes become more crucial at the confirmation stage. Depending on the support for adoption of the innovation and the attitude of the individual, later adoption or discontinuance happens during this stage.

2.1.8. Factors Affecting Adoption and Diffusion of Agricultural Innovations

Factors affecting adoption and diffusion of agricultural innovations include personal and socio-economic factors; socio-cultural, situational and technological forces; gender; access to extension services**,** characteristics of the innovation, institutional constraints as well as research-extension farmer linkage problems.

2.1.8.1 Personal and Socio-Economic Factors

Mere provision of agricultural information to farmers does not guarantee its use. This is because a host of social, economic, and psychological factors influence the rate of agricultural information use (Donkoh and Awuni, 2011; Surry, 1997; Akande, 1999). Among the factors Rogers (2003) identified, is the social system into which the information is delivered. For Umunna, (2010) socio-economic and personal characteristics of farmers associated positively with the use of agricultural information. Sezgin *et al*, (2011) also indicated that the age, education level, and income level of the farmers, operational goal of the farm, participation in extension studies, making use of mass media means and benefitting from agricultural incentives are influential on the adoption of innovations. For Donkoh and Awuni, (2011), when the educational levels of farmers are too low, it would take a lot of efforts to introduce modern technologies to them.

Enete and Igbokwe, (2009) are however of the view that age is expected to negatively influence adoption because younger farmers are more dynamic with regards to adoption of innovations than older farmers. Martey *et al*, (2013) also posits household heads that are married also have a higher probability of adoption than their unmarried counterparts. This is because they are normally assisted by their spouses in production, processing and marketing decision making. Similarly, household size is expected to positively influence farmers' adoption of agricultural innovations because members of the households serve as sources of farm labour.

Unlike experienced farmers, educated farmers are more prone to adoption because they have tendency to co-operate favourably with other farmers (Martey *et al*, 2013; Enete and Igbokwe, 2009; Ofori, 1973; Southworth and Johnston, 1967; and Schultz 1945). It means educated farmers who are experienced can adopt innovation better than inexperienced educated farmers.

Socio-economic and demographic characteristic of farmers influence their ability to adopt or reject agricultural innovations because availability of credit and the associated cost of credit according to Sindi (2008) are crucial in the success of the agricultural industry.

2.1.8.2 Socio-Cultural, Situational and Technological Forces

Innovations could also meet resistance from socio-cultural, situational and technological forces. The innovation may not be compatible with social norms, values and lifestyle; or may not go well with the economic strata; or be

technologically complex, leading to fear to usage, obsolescence and risk (Donkoh and Awuni, 2011; Loudon and Bitta, 2002).

This appears to be the case worth considering since there exists a wide gap between farmers' improved technology yields and farmers' traditional technology yields. This scenario is attributed to the gap between available agricultural information on improved practices and its use. Thus, in agricultural information use studies, it is usual to investigate the personal and social characteristics of farmers in order to understand their relative influence in the farmers' information use behaviours (Umunna, 2010; Donkoh *et al*, 2006; Braak, 2001).

First of all, information usage depends on the ability of the user to access information, and later uses it. This ability is dependent on certain cultural, socio-economic, personal, political and geographical variables. It also includes the appropriateness of the information, the credibility of the information channel, and the information provider's characteristics (Umunna, 2010; Braak, 2001). This is because if the information provider, such as an Extension Officer, is perceived by the farmers to be a dishonest, untrustworthy and an unreliable personality, any information provided by him, irrespective of the source, would not be regarded as useful or important. Weir and Knight (2000) suggest that the operation of social networks is crucial in the spread of innovations. It means farmer groups and associations facilitate the adoption and diffusion of agricultural innovations. Mass media also affect the adoption of agricultural innovations positively (Sezgin *et al*, 2011) and should be used to introduce the innovations to farmers for massive

adoption. Other factors that affect adoption of agricultural innovations include gender.

2.1.8.3 Gender

It is a known fact that men and women adopt agricultural technologies at different rates. Several reasons could account for this. For example, evidence from Ghana suggests that gender-linked differences in the adoption of modern maize varieties and chemical fertilizer are not attributable to inherent characteristics of the technologies themselves but instead result from gender-linked differences in access to key inputs like land, labour, and contact with extension services (Donkoh and Awuni, 2011; Doss and Morris 2001; Morris and Doss, 1999).

Apusigah (2004) asserts that gender constitutes the entire ambit of relations that govern the social, cultural and economic exchanges between women and men in different facets of life. Mehta and Srinivasan (2000) are also of the view that gender is central to how societies assign roles, responsibilities, resources and rights between men and women. Adoption of NERICA is likely to be affected by gender because in many communities, there exist gender biases to the disadvantage of women. Martey *et al* (2013), assert that females are normally occupied with domestic activities such that they do not have enough time to participate in Rice Development Projects (RDP) compared to their male counterparts. So they are likely to have lower rates of innovation adoption than their male counterparts.

In Ghana, women tend to own smaller plots of land than men, and a greater proportion of women are landless, which goes a long way to affect adoption of agricultural innovations.

Similarly, in many parts of sub-Saharan Africa, women have greater difficulty than men obtaining labour, especially male labour needed for land preparation activities such as clearing, burning, and ploughing. So it limits women's ability to adopt innovations than men.

2.1.8.4. Access to Extension Services

The uptake of new technologies is often influenced by the farmer's contact with extension services, since extension agents provide improved inputs and technical advice. Morris *et al*, (1999) posit that frequency of contact with extension agents is strongly associated with the gender of the farmer. The nature of extension staff in Ghana mirrors Morris *et al*, (1999) position because the majority of agricultural extension staff is male, who easily flow with their male clientele. Farmers who have frequent and more access to extension services tend to adopt innovations easily than those that do not. However, Jamison and Moock (1984) tested the effect of schooling and extension contacts on the adoption and diffusion of agricultural innovations in Nepal. They found that individual extension contacts are less important than extension activities in the site in influencing the adoption and spread of innovations. It means that extension activities in promoting innovations in a particular geographical area foster farmers' adoption of the innovation than when individual farmers contact extension officers for assistance. This is because such individual contacts and extension assistance may not lead to massive adoption and diffusion of agricultural innovations compared to extension activities involving farmer groups in whole communities, districts, regions or countries.

There is therefore the need to foster appropriate research extension farmer linkages to ensure free flow of information to and from farmers. It is imperative to heed the perceptions of farmers, vis-à-vis those of researchers on the adoption of improved rice varieties. This is because some farmers may prefer lowland rice to upland rice or the other way round. The planting methods also differ depending on the rice types, ecological conditions of the area and demographic characteristics of farmers.

2.1.8.5. Characteristics of Innovation

Perceived characteristics of Innovations that enhance their adoption are relative advantage, compatibility, trialability, observability, complexity, and the possibility of re-invention.

Rogers (2003) defined these perceived characteristics as follows:

Relative Advantage: Is the degree to which the innovation being communicated is perceived to be better than the existing technology or practice.

Compatibility: Is the extent to which the new idea is seen to be compatible with the existing practice or environmental conditions, socio-cultural aspirations and indigenous technology.

Triability: Is the degree to which the new technology being introduced can be tried on pilot basis before its subsequent adoption and diffusion.

Observability: Is likewise a positive attribute of innovations, which indicates the degree to which the results of an innovation can be observed, with time, so as to decide whether to adopt or reject it.

Complexity: Is a negative attribute of innovations that indicates the degree to which the new technology is perceived to be complex with regards to its adoption.

Adaptability: Is the sixth attribute of innovations that enhances their rates of adoption if they have the possibility of re-invention to suit the farmers' local conditions.

Hence, innovations that are perceived to have high degrees of relative advantage, compatibility, triability, observability and less complexity with the possibility of re-invention are more likely to be adopted than those that do not.

2.1.8.6. Institutional Constraints

While agricultural industries tend to be competitive, the perfectly competitive model does not necessarily apply since farmers may face a significant number of institutional constraints and policies which affect their behaviour significantly and result in outcomes that are different from those predicted by the perfectly competitive model. Institutional constraints may affect the patterns of adoption of new technologies, but on the other hand, the introduction of new technologies may affect the institutional structure and operation of agricultural industries (Doss and Morris 2001; Sunding and Zilberman, 2000).

One of the key constraints to adoption and diffusion of innovations is credit. If the price of credit is higher for smaller farms, that extra hurdle will reduce the minimal farm size that is required for new technology adoption and will slow adoption by smaller sized farms (Sunding and Zilberman, 2000). Thus, advantageous credit conditions may be another reason larger farms adopt new technologies earlier than small sized farms.

Another factor is the existing land tenure system. The existence of a well-functioning land rental market may accelerate adoption of technologies that require a significant scale of operation. In fact, some farmers may augment the land utilized by them by renting land from others, thus enabling them to adopt large equipment (Doss and Morris 2001; Sunding and Zilberman, 2000). Complementary inputs and infrastructure likewise affect adoption and diffusion of innovations.

The introduction of new technologies may increase demand for complementary inputs and when the supply of these inputs is restricted, adoption will be constrained (Donkoh *et al*, 2006). For example, some high yielding crop varieties like maize require increased water and fertilizer use. Hence, private or public investment in the drilling of wells or provision of irrigation facilities, and the establishment of fertilizer production and supply facilities would remove these constraints and contribute to the diffusion of modern wheat and rice varieties significantly. Adoption rates in high yielding crops would be higher if complementary disease-control technologies are available.

2.1.8.7. Research-Extension-Farmer Linkage Problems

A study conducted among Agricultural Innovation researchers in Kenya revealed lack of funds for promotion, poor promotional infrastructure, and lack of policy and commitment from research institutions as some of the research-extension-farmer linkage problems (Bwisa and Gakuhi, 1999). They found that many research findings (innovations) do not reach their intended beneficiaries due to the above constraints. The research findings therefore remain on the book shelves of the research institutions and the university libraries.

Three basic assumptions underlie this concept. First, agricultural technology is a complex blend of materials, processes, and knowledge. Second, because of the complexity of agricultural technology, different institutional arrangements are needed to transfer different types of technology to technology users. And, third, most small-scale farmers in developing nations operate relatively complex farming systems in each Agro Ecological Zone (AEZ) of the country; consequently, farmers in different AEZs need access to a wide variety of locally validated technologies if they are to increase their productivity (Swanson, 1993). So there should be an appropriate mechanism for research-extension-farmer linkages.

In an effective Agricultural Technology System (ATS), numerous groups depend on one another to get improved technology to farmers. These groups have to work in concert because failure of one link in the chain diminishes the overall performance of an ATS (Merrill-Sands, 1992). Donkoh and Awuni (2011) blamed the problem of poor extension delivery system in Ghana and many other developing countries on improper motivation of the inadequate extension staff.

In short, through collaborative programme activities, research and extension personnel develop a positive professional relationship that is important, if not essential, in facilitating the flow of technology and feedback information within an ATS (Donkoh *et al*, 2006; Swanson, 1993).

2.1.9. Attributes of Rice Varieties that enhance their Adoptability by Farmers

Farmers' adoption of rice varieties may differ depending on the attributes (positive or negative) of the various varies. The choice of one variety over others is greatly influenced by the balance between the positive and negative attributes of the varieties.

Depending on the preferences, resources, and constraints that individual farmers face, a beneficial attribute for one farmer may be a negative one for another, or the balance between positive and negative traits may be acceptable for one farmer but not for another (Bellon, 2001). Crop attributes such as grain quality, straw yield, grain yield, and input requirements are all factors farmers consider in assessing a new technology, like improved crop variety (Taxler and Byerlee, 1993). If the crop quality is poor, farmer would have low inclination towards its adoption. There is therefore the need to improve the crop variety to suit both climatic and demographic factors of the farming community.

Improved crop varieties stand the chance of adoption by farmers. Crop breeders need to know farmers' preference for a particular crop variety so as to set appropriate goals in their breeding programmes, delineating their target environment, identifying the breeding stock, and defining the management treatment for breeding work (Millar, 2008; Sperling, *et al*, 1993).

According to Africa Rice (2016), the factors affecting the choice of NERICA to be planted in a given location include; the amount of rainfall, temperature, iron content in the soil, presence of diseases and pests such as rice blast (a fungus) and leaf-eater (an insect), as well as tastes and preferences of the local people. For example, in

areas where annual rainfall is scanty, rice is grown as a rain fed upland crop (ICAR, 2006; MoFA, 2011). Agro Ecological conditions therefore play a key role in the adoption and diffusion of improved crop varieties among farmers. For example, in 2004, field conditions at SARI clearly showed that dry upland conditions were not well adapted to NERICA, and hydromorphic conditions were more preferable (www.savannahagriculturalresearchinstitute.org). That would certainly influence farmers' decision to adopt or not adopt the NERICA. Usually, farmers prefer high yielding crop varieties that are hardy and acclimatized to the local climate and management practices. MoFA (2010) reported that the weather for the period January – December 2010 in the Tolon/Kumbungu District was dry, which facilitated the harvesting and drying of most cereals including the NERICAs. The average temperatures at the time ranged between 20^{o}C and 33^{o}C during day and night respectively. However, the weather for the period January – December 2011 was described as abnormal because the rains began late and stopped early in September (MoFA, 2011). Average temperatures ranged between 20^{o}C and 34^{o}C during day and night respectively. These attributes or phenomena do not necessarily guarantee farmers' adoption of a rice variety, due to other factors.

Similarly, the NERICA varieties introduced in Ghana take between 90 and 95 days to mature, have good taste and are drought resistant. As at September 2007, there were more than 400,000 hectares of potential land available in the [Northern Region] for local rice production, but farmers were reluctant to go all out because the government had encouraged the importation of rice (www.savannahagriculturalresearchinstitute.org). In 2014, Ghanaians consumed 754 metric tons of rice 52% of which was imported (https://www.

ghanabusinessnews.com). The failure of Ghanaians to patronise local rice also affected the adoption and production of NERICA (htts://en.wikipedia.org). That shows that consumers' tastes and preferences of rice varieties influence their adoption by rice farmers. SARI was however determined to continue to develop varieties of rice to help local farmers boost production (www.savannahagriculturalresearchinstitute.org). SARI also trains local farmers to grow NERICA (htts://en.wikipedia.org; http://www.modernghana.com). Thus, suitable innovations with training components of "how tos" are easily adoptable by farmers. Nutritional quality of rice varieties is another attribute that determines their adoptability and farmers' or consumers' preference.

In terms of nutritional quality, rice, along with wheat and corn supply almost 60% of the dietary energy and protein derived from plants. Rice alone accounts for 40% of the protein in Asia diet. In India, rice provides 25% of the protein requirements besides being the principal source of vitamins (thiamine and riboflavin) and minerals (Fe and Ca). Therefore, nutritional quality is as important as yield and cooking quality of rice for Asians countries including India (ICAR, 2006).

The case in Ghana is not very different except the percentage of rice protein in the Ghanaian dish might be low. It could be estimated at 20%, since rice is one of the staple foods of Ghanaians. It is said to be the second largest cereal consumed after maize in Ghana and it has become a common feature in Ghanaian diets (http://www.ghanabusinessnews.com). Rice protein is biologically the richest by virtue of its high true digestibility (88%), high lysine content (4%), and relatively better net protein utilization. Yet, it is nutritionally handicapped on account of its

inherently low protein content (6-8%) and inevitable milling lose of as much as 15-20%. Though milling is an unavoidable process causing considerable losses of nutrients, such losses can be minimized by using modern milling technology (ICAR, 2006; MoFA, 2011). Milling causes both nutritional and grain losses to rice.

Properly parboiling the rice before milling can reduce some of the nutritional losses. The grain lose is not a loss per se since the supposed loss grains could be retrieved by winnowing the rice chaff after the milling process, though quite laborious. However, modern milling technologies reduce the grain and nutritional losses quite drastically. That is why the NRDP is a complete package with modern rice mills at vantage points for processing, and good road network as well as transportation facilities. Hence, farmers stand the chance of enjoying higher yield, increased productivity, shorter production cycle, high nutritional quality, reduced grain loss due to processing, good cookability, increased palatability and nice perfume, by adopting NERICA. Martey *et al* (2013), state that higher price serves as an incentive for farmers to increase their production and also seek innovative methods of meeting the demands of buyers.

2.2. Empirical Review

This section of the literature review looks at works related to the topic under study. It is broken down into the following sub-headings: Adoption of Agricultural Innovations in Sub-Saharan Africa; Adoption and diffusion of NERICA across Africa; NERICA Rice Dissemination Project (NRDP) in Ghana; Utilization of NERICA Varieties in Ghanaian Dishes; the NRDP Exit Strategy; and Adoption of NERICA in the Tolon District.

2.2.1. Adoption of Agricultural Innovations in Sub-Saharan Africa

Dissemination of agricultural innovations in Sub-Saharan Africa (SSA) is not an overwhelming success due to many reasons. Taborn (2011) asserts that some research findings are not normally translated into ground-proven technologies. Some innovations are also simply technically inappropriate. Other innovations may work in the technical sense but are not adapted to the place-specific situation.

The so called success stories bring to the fore that several concomitant conditions have to be at hand for success; factors often taken for granted in developed countries includes functioning markets, credit facilities, supporting policies, and strong institutions. For sustained success, presence and stability of these factors over longer periods is a further precondition.

It is often claimed that investments in agricultural research yield good returns (Renkow and Byerlee, 2010). Though some agricultural innovations emanating from research do not yield good returns, those that yield good returns can have an enormous impact. Addressing the right problem, using the right tools is the key to get the best return to invested resources. To varying degrees, scientists have to take part in processes to describe impact pathways, estimated impact, and possible counterfactuals (Taborn, 2011).

A study in Uganda by Kijima *et al* (2005) also related household characteristics to adoption behaviour. They stated that distance to input supplier as a market access of the household does not have an effect on adopting NERICA. Also, a farmer's sex and education level do not affect the area planted to NERICA. So in households whose heads are older, the area planted to NERICA is smaller (Kijima *et al*, 2005).

The findings are often contradictory. A 2009 study on adoption in Sub-Saharan African countries estimates high adoption rates of NERICA varieties, provided the full rice farming population of these countries could be exposed to NERICA varieties and provided access to seed (Diagne *et al*, 2009).

Adoption of agricultural technologies, notably in Africa, could therefore be more successful if it takes on an integrated approach. The integrated approach puts different demands on science to follow, learn, understand and facilitate multiple innovation processes building on best fit packages or general principles.

2.2.2 Adoption and Diffusion of NERICA in Africa

The New Rice for Africa (NERICA) has been praised as a miracle crop for Africa and an illustration of an emerging African Growth Rate (GR). The inter-specific cultivar of rice, developed by the now Africa Rice Centre (WARDA), was created in 1994 by crossing African rice with high-yield Asian varieties of *Oriza sativa*. Originally developed for upland cultivation, there are now 18 upland NERICAs and 60 low-land NERICAs.

The first generation of NERICA varieties was introduced through participatory varietal selection trials in 1996 in Côte d'Ivoire and later in other member countries of AfricaRice in 1997 (Diagne *et al*, 2010). NERICA1 and NERICA2 were officially released in 2001 in Côte d'Ivoire (Diagne 2006; Science Council 2007; Diagne *et al*, 2010). Since then, NERICA varieties have now been introduced in more than 30 countries in Sub-Saharan Africa using Participatory Varietal Selection (PVS) approaches, mostly thanks to the African Rice Initiative (ARI).

Field tests of the varieties show promises for higher yield under varying conditions, more protein, shorter growing season, and a greater resistance to pests and diseases (Taborn, 2011). However, the primary beneficiaries of the multinational NRDP, across West Africa, are upland rice producers in rural communities, who had limited education and training (AfDB, 2014; www.afdb.org). They are mostly subsistence farmers who sell marginal surpluses to meet cash expenses, such as for education, health care, and other basic household needs (AfDB, 2014; www.afdb.org). So they are unable to raise adequate capital to increase production and productivity as anticipated. Larsson (2010), reports that in places where NERICA has been introduced, overwhelming evidence from the field of substantial yield benefits are slim.

Diagne *et al*, (2010) also praised NERICA varieties as a successful innovation for Africa's rice farmers but indicated that the adoption rates are low. They explained that the low rates illustrate a largely unrealized potential adoption rate unless the full rice farming population of the African countries are exposed to NERICA varieties and provided access to seed. It means the fact that an innovation has been described as successful does not necessarily mean its adoption would be successful, due to several factors.

NERICA cultivation in uplands of West Africa is estimated at 6.7% (CGIAR/Science Council 2007). NERICA yields are estimated at 1,500 kg/hectare without fertilisers and 2,500 kg/hectare using fertilisers compared to traditional rice yields of 800 kg/hectare (AfDB, 2014; www.afdb.org).

Limited studies of adoption have been carried out in Benin, Cote d'Ivoire, Guinea, and the Gambia. As new NERICA variety diffusion and adoption is not random, the Average Treatment Effect framework has been applied to remove non exposure and selection bias (WARDA, 2008). Adoption rates differ between the countries, as should be expected. Some findings on determinants of adoption of NERICA tell that in:

Cote d'Ivoire: growing rice partially for sale, household size, growing upland rice, past participation in Participatory Variety Selection, and living in a PSV-hosting village had a positive impact; whereas age of farmer and having a secondary occupation had a negative impact.

Guinea: positive impacts were noted for participation in a training programme and living in a village with NGO SG2000 activities;

Benin**:** Land availability, living in a PSV-hosting village, varietal attributes such as swelling capacity and short growing season were important determinants of adoption; and;

The Gambia**:** Living in a village where dissemination by WARDA, contacts with the NARI, access to credit, and experience in upland rice farming had a positive impact (WARDA, 2008).

The advantages of NERICA may not be higher yields per se, but early maturity, tolerance to water stress, good taste and flavour, and short straw. A study conducted in Uganda (Kijima *et al*, 2005) showed that even though NERICA is said to be drought resistant, its production is subject to large variations, depending on rainfall. Effect on yields and determinants of adoption seem to be quite heterogeneous over countries and farmer categories (CGIAR/Science Council 2007). The AfDB (2014)

has it that about 80% of the targeted project beneficiaries were women and poor people who could not maximize the potentials of the magic crop. Yet, the relative advantages of NERICA, over other rice varieties, made it adoption and diffusion possible across West Africa.

In 2011, the actual adoption rate across West Africa (Benin, Gambia, Ghana, Guinea, Nigeria, Mali and Sierra Leone) was estimated to be about 43%, while the potential adoption rate was estimated at about 63% (AfDB, 2014; www.afdb.org). This 20% gap seems to be due to a lack of both awareness and access to NERICA seed, showing there is still a need to increase investment in NERICA dissemination**.** This is due to the fact that the supply of NERICA seeds has been a major constraint in Uganda and in other African countries (Diagne, 2006).

2.2.3. NERICA Rice Dissemination Project (NRDP) in Ghana

The main goal of the NRDP in Ghana was to contribute to poverty-reduction and food security, through enhanced access to high yielding NERICA upland rice varieties (http://www.modernghana.com). The objective(s) of the project were (i) to contribute to increasing locally produced rice for food security; and (ii) to conserve foreign exchange earnings through import substitution (http://www.modernghana.com). From all indications, the NRDP became one of the projects that made the necessary impact in the context of improved household food security; increased farm incomes; employment creation; crop yield improvement; and enhanced livelihood of household and communities that benefited from it (Ministry of Food and Agriculture [MoFA], 2010).

An analysis of the project report shows that ten districts in Ghana, including Tolon-Kumbungu, benefited from the dissemination programme. The others were Savelugu-Nanton, West and Central Gonja, all in the Northern Region. The rest were Hohoe, Jasikan, Kadjebi, and Kpando in the Volta Region as well as Ejura-Sekyeredumase in the Ashanti Region and Atebubu-Amantin in the Brong Ahafo Region. However, Ejura-Sekyeredumase, Hohoe, Tolon-Kumbungu became the main project districts whereas the other seven were regarded as adjoining ones (MoFA, 2010). This makes the Northern Region one of the beneficiary regions of government interventions projects in the rice sector. However, despite the many interventions of rice development projects in Northern Ghana, many of the farmers are still producing at the sub optimal level due to the differences in the level of engagement and technology uptake (Wiredu *et al*, 2010).

In all, approximately 22,579 households benefited directly from the project, and are currently involved in the cultivation, processing and marketing of NERICA varieties in Ghana. Over the project period, a total of 114.72 tons and 1,128.07 tons of foundation and certified seeds were produced and made available for NERICA production. Two of the NERICA lines (N1 and N2) were releases in 2010, during the period. Meanwhile, NERICA 1 and 2 were released in Côte d'Ivoire in 2001 (Diagne, 2006). For capacity building, about 117 technical staffs of the ministry of Food and Agriculture were trained on various techniques for upland rice production. Farmers and other stakeholders along the value chain were also trained under the project to produce, process, package, and market their produce (MoFA, 2010).

According to MoFA (2010), approximately 12,228.5 hectares of land was cultivated to the NERICAs over the project period, resulting in the production of approximately 26,922.7 tons of paddy rice (equivalent to 17,499.4 tons of milled rice). At the community level, facilities including three commercial rice mills and feeder roads were also provided to enhance grain quality and facilitate the easy evacuation/haulage of rice to the marketing centres (MoFA, 2010).

It is therefore clear from the project report that the project provided the necessary conditions for the adoption and diffusion of the NERICA varieties in the Tolon and the other districts in Ghana.

2.2.4. Extension Teaching Methods Used to Disseminate NERICA in the Tolon and Kumbungu Districts in the Northern Region of Ghana

The following innovation dissemination methods were used to introduce NERICA to farmers in the Tolon and Kumbungu Districts: block farms, demonstrations, awareness creation, field days, and field visits, training sessions, and study tours (MoFA, 2011). These methods are in tandem with the Indian Council of Agriculture (ICAR) (2006) which has extension methods of disseminating Agricultural innovations as indicated earlier.

(a) Block Farms

MoFA (2011) stated that a total of 3,584 farmers consisting of 2,418 males and 1,166 females in 102 groups undertook block farming to try the gains and fortunes of the innovation**.** The groups were supported with land preparation, seed, fertilizers and weedicides. Each of the grain farms yielded 5, 6, 7 or 8 bags/ha.

(b) Demonstrations

The report showed that each AEA handled two acres demonstrations of NERICA 3, 4, 9 and 14. The demonstration lay out were in two: method and result demonstrations. It was found that four varieties of rice were planted on one acre in some cases of the experimentation. In some other cases, two varieties of rice were planted on one acre. These demonstrations served as training centres for farmers in the dissemination of the innovation. This information from the project report collaborate with ICAR (2006) that result from demonstrations helps the farmers to learn by seeing and doing because this enhances effective learning and promotes technologies. It means farmers' participation in a demonstration exercise is a necessary condition for adoption of technology but not a sufficient condition. Martey *et al* (2013) examined the socioeconomic and institutional factors that influence participation of smallholder farmers in rice development projects in Northern Ghana, using the Probit model, and concluded that participation in rice development project is an important platform for joint learning and technology transfer.

(c) Awareness Creation

The report revealed that awareness creation and sensitization methods that were used in 2010 were mainly by radio and public fora or campaigns in the beneficiary communities. The strength of this approach, as reported by (MoFA, 2011) helped enhanced the promotion of NERICA in the district. ICAR (2006) does not mince words on the above awareness creation methods. Like radio, other methods such as group discussions, general meetings and campaigns all helped reach out to large numbers of farmers during the dissemination processes.

(d) Field Days

It was found in MoFA (2010), that 18 field days were organized by 9 AEAs with an average of 2 field days per AEA. The field days were used to create awareness on the technologies being promoted and to build capacity of beneficiaries on technologies being demonstrated to the farmers. Some of the topics that were discussed on the field days included land preparation, planting, basal fertilizer application, weedicides application and rougueing. The farmers therefore applied the knowledge gained from the field days on their own NERICA farms during the NRDP.

(e) Field Visits

The report indicated that field visits were ways by which extension workers trained farmers to adopt innovations. The visits were farm and home visits as well as peripatic team visits, which made it easier for both the farmers and the extension workers to have direct and face-to-face contact. This agrees with ICAR (2006) and Rathod (2016) that farm and home visits are the direct or face-to-face contact by an extension worker with the farmer or the members of his family whereas peripatic team visits are made by a team of three to five subject matter specialists, led by an extension officer

It was found that peripatic team visits were however not made to the project sites. This is because specialists in the area were not immediately identified and contacted by either the DDA or the AEAs. Since the purpose of peripatic visits was not to present ideas on some timely topic to farmers to seek and answer questions, and eventual provision of advice to the farmers, peripatic visits were not required for the NRDP, since the MoFA and SARI staffs were in charge.

(f) Training Sessions

The report revealed that training sessions were organized for both farmers and technical staff. The farmers who were trained were expected to train their fellow farmers at the community level.

(g) Study Tours

Study tours were organized for the farmers in the project. The farmers from various districts of the NRDP visited the various project sites to learn from other farmers. For example, there was a visit to Tolon by staff and farmers from Ejura; a visit of staff and farmers from Tolon to Hohoe; a visit by Central Gonja staff and farmers to Tolon; and a visit by West Gonja staff and farmers to Tolon. These visits provided the visitors with the opportunity to interact with project staff and NERICA group leaders from the communities.

The study tours helped farmers to learn from each other's experiences. This confirms the explanations by Cole 1981, ICAR (2006), and Rathod (2016) that tours are conducted for farmers to convince them and to provide them with an opportunity of seeing the results of new practices, demonstration of skills, and new implements. It gave the farmers some ideas on the application and suitability of these practices to their own areas.

2.2.5. Utilization of NERICA Varieties in Ghanaian Dishes

Rice is the second largest cereal consumed after maize in Ghana and has become a common feature in Ghanaian diets. Ghana's per capita rice consumption is currently estimated at about 58.0 kg with a current demand of milled rice for consumption

estimated at over one million metric tons milled rice with about 40 per cent only produced in Ghana (https://www.ghanabusinessnews.com). Rice consumption in Ghana had seen a tremendous growth in the past six years, from about 542,000MT in 2009 to around 748,000MT in 2014 (https://www.newsghana.co.gh/rice).

As part of the efforts to promote the cultivation and utilization of NERICA varieties in Ghana, the NERICA Project Coordination Unit (CPU) in collaboration with the Women in Agricultural Development Directorate (WIAD) organized a series of organoleptic tests across the country.

As stated earlier, rice is used in the preparation of several dishes in Ghana. These include *jollof* rice, plain rice, *waakye* (rice mixed with beans), rice porridge, rice balls, pancakes, and biscuits. WIAD therefore organized sensitization and educational campaigns in the three main project districts (Tolon-Kumbungu, Hohoe, and Ejura-Sekyeredumase) to assess consumers' acceptability of the NERICAs. A week long test was also conducted in Accra at the WIAD's kitchen and catering laboratory to popularise the NERICA; encourage consumers to patronize the product being promoted on the market; and to inform farmers and traders about the level of acceptability of the new rice (MoFA, 2010). However, the pink colour of milled NERICA is usually not appreciated at the market level (WARDA, 2008).

At the end of the tests, consumers and judges as well as the cooks and laboratory technicians rated the NERICAs based on a scale from 1-5 and made appropriate recommendations. The performance of NERICA-based processed products suggests that NERICA flour can efficiently substitute for wheat flour in many confectioneries (WARDA, 2008). Empirical studies show that milled NERICA varieties have higher

protein contents and show a better balance of amino acids as compared to both imported varieties and the international rice standard (WARDA, 2008).

Recommendations from the tests aimed at the adoption, diffusion and utilization of NERICA in Ghana. One of the recommendations was that the NERICA should be promoted well in the School Feeding Programme in the basic schools, provided the idea would be accepted, implemented and sustained by the government. The project exit strategy was to ensure sustainability of the innovation among beneficiaries, which does not seem feasible at the moment.

2.2.6. The NRDP Exit Strategy

The project report showed that there was an appreciable level of acceptance of the NERICA varieties among producers, consumers, processors, and other stakeholders. So an evaluation workshop was organized at the end of the project to develop the exit strategy in such a way that the project's achievements could be secured and sustained. The strategy also attempted to address all the challenges that emerged during the implementation as well as sustain the continued use of recommendations made during the project's lifespan to ensure critical maintenance of the rice variety and its products on the Ghanaian market (Ministry of Food and Agriculture [MoFA], 2011).

The exit strategy had four components. Namely, technology transfer strategies, production support strategies; capacity building strategies, and project management and coordination strategy (Ministry of Food and Agriculture [MoFA], 2010). All these strategies were meant to ensure sustainability, adoption and diffusion of the innovation in the country.

The project therefore enhanced the National Agricultural Research and Extension Services' capacities; reliance on these services was deemed critical to ensure the consolidation of the project's achievement when the project closed (AfDB, 2014; www.afdb.org).

2.2.7. Adoption of NERICA in the Tolon and Kumbungu Districts

Asuming-Brempong *et al* (2011) studied adoption of NERICA in the Tolon-Kumbungu District and revealed an adoption gap of 44%, due to incomplete diffusion of the innovation. The study showed that 90% of rice farmers in the district had knowledge of an improved rice variety. That meant that much awareness was created among the rice farmers to enable them know and decide whether to adopt the variety or reject it. Reasons given for the high level of awareness were the farmers' closeness to the Savannah Agricultural Research Institute (SARI) and the University for Development Studies (UDS); and that most of the new rice varieties that have been developed in the country were vigorously promoted in the Northern Region of Ghana (Asuming-Brempong *et al*, 2011). The farmers are therefore at an advantage when it comes to introduction of new rice varieties in Ghana.

Unlike other improved rice varieties which had long been disseminated to them, the NERICA varieties were disseminated and the project ended a year before the study by Asuming-Brempong *et al* (2011) and therefore might have not yet diffused into the districts. Therefore, only 1% of farmers (contact farmers in the district who worked closely with extension officers and researchers) had adopted the NERICA as at the time of the study.

Another study on the NERICA adoption in the district by Glenna *et al* (2012) showed that two groups of farmers were purposively selected to grow seed rice and grain rice during the trial and dissemination periods. Since they were the selected few, they may have constituted the 1% who had the exposure and subsequently adopted the innovation. Others who may have fallen in the same bracket would be their immediate family members and close allies or neighbours.

Unlike other innovations that were generated by research institutions and handed over to MoFA to be disseminated by AEAs to farmers, the NERICA variety dissemination was a collaboration between MoFA and SARI in a period of five years. The joint collaboration should have added impetus to the exposure and adoption processes except the period was relatively short for any massive diffusion. Innovations, once disseminated, are supposed to diffuse naturally within the social system but this is not always the case due to several factors. Paramount among these factors is the innovativeness of the potential adopters. Time is one of the key factors of innovation adoption; hence the adoption rate is likely to increase with time.

Asuming-Brempong *et al* (2011) therefore gave a parametric estimation of 92% and 90% adoption of improved rice varieties among the exposed and unexposed farmers respectively. They pecked the potential adoption rate for the entire population at about 91%, without giving a specific time frame. That created a research gap in their study. Rogers (2003) argues that including the time dimension in diffusion research illustrates one of its strengths.

Their estimation also was for the adoption of improved rice varieties and not specifically NERICA. That could be misleading because the farmers' adoption rate might significantly increase for other improved rice varieties but insignificantly for the NERICA. So to lump all improved rice varieties together and estimate their potential rate of adoption at 91% is quite general. It is therefore worthwhile to distinguish the potential increased rate of adoption of NERICA.

Yoko (2008) found that in Uganda the adoption of NERICA varieties is influenced also by opportunity cost and risks faced by households, in addition to farmer exposure to the varieties. That means exposure and incentives are not enough to make farmers adopt the NERICA variety. They necessarily need to decide to adopt the variety. In this case, the farmers would have to choose to produce, consume and market the NERICA and not any other improved rice variety. However, in situations where farmers produce more than one rice or crop variety, (perhaps for food security reasons) they may have to produce more of the NERICA and less of other rice or crop varieties. This is because adoption is also measured by the size of farmers' farm devoted to the cultivation of the newly adopted crop variety. That is why farmers' access to farm land, labour, extension services, capital or credit is an essential factor to adoption of farm innovations (Morris and Doss, 1999). For Asuming-Brempong *et al* (2011) farmers' age and access to extension affect their adoption rate of improved rice varieties. Their findings agree with that of Morris and Doss (1999) in terms of contact with extension staff in the adoption and diffusion process.

Asuming-Brempong *et al* (2011) concluded their research by stating that the existing adoption gap in the Tolon-Kumbungu District can be minimized if the promotional activities are improved to include the majority of the rice producers in both the SARI

project and non project areas. They recommended that much effort and resources be invested in promotional activities to facilitate both the exposure and adoption of the NERICAs among farmers in Ghana (Asuming-Brempong *et al*, 2011). That would indeed go a long way to achieve the objectives of the project.

Glenna *et al* (2012) indicates that the objectives of the NRDP would be a mirage if efforts are not made to ensure "total adoption" and the existing adoption gap closed. The project that introduced NERICA to farmers in the Tolon and Kumbungu Districts was a very comprehensive one except that it was short lived.

NRDP was part of a larger effort by the Ghanaian government to help farmers in the three northern regions of Ghana to increase rice production, including efforts to assist farmers with land preparation and to obtain access to certified rice seed and subsidized fertilizer (Glenna *et al*, 2012; AfDB, 2012; www.afdb.org). The innovation was therefore comprehensively packed aimed at helping farmers help themselves to improve their standards of living and ensure national food security as well as reduce import. All things being equal, the innovation is expected to diffuse throughout the two districts and beyond and sustained. However, in the absence of governmental and donor incentive packages to persuade more farmers into adoption, the diffusion process is likely to be short circuited.

Although the farmers intended to continue producing NERICA after the dissemination period (seed project), which provided them with seed, inputs, and a guaranteed price, they also expressed concerns about sustainability. One of such concerns was that for them, removing the incentives for adoption and sustainability is like trying to get a kid to try to walk and abandoning the kid mid-way in the

process. In effect, the kid would go back to the point at which he started and continue to craw instead of walking.

For such farmers, it would be better for them to fully adopt the innovation if the project with its incentive package is continued for a longer time (Glenna *et al*, 2012). But for how long should the project be continued? The longer it continues the more dependent the participant also become. That means that the farmers would continue to use the innovation as long as the project incentives remain in force. One might argue that the farmers were merely asking for an extension of the project so they could properly get adjusted well before it ended but that may be far from the truth. Glenna *et al* (2012) supported the farmers' view for SARI should continue the intervention project for many more years and also to expand the programme to ensure total adoption. For him, that would be the most effective way for Ghana to expand rice production. Otherwise, it would be doubtful that farmers would continue to produce NERICA varieties at the same level of quality in the future. Glenna *et al* (2012) empathized with the farmers. It therefore appears that the small holder farmers enjoy being spoon-fed for a long time instead of learning to feed themselves. Osagyefo Dr. Kwame Nkrumah stated in 1957, during Ghana's independence struggle, that "the African is capable of managing his own affairs." But facts on the ground, after the independence, indicate that that statement is far from reality. This is because the African still depends on his former colonial masters and donor funding so as to manage his affairs. That is the irony of the scenario we seem to see in the NERICA adoption process in the Tolon and Kumbungu Districts. The programme planners think that the farmers would be able to adopt the innovation and continue with the diffusion process so as to derive the maximum benefits from the

intervention but the farmers think otherwise. The project therefore devised various exit strategies to ensure the continued promotion and patronage of the innovation (MoFA, 2011; AfDB, 2014; www.afdb.org). However, the farmers kept asking for more time and support. Many Africans still think like these farmers. They wish the colonial masters had stayed a bit longer to develop Africa better than it is now. But that is a façade.

2.3. Conclusions on the Theoretical and Empirical Framework

From the literature reviewed in this chapter, adoption and diffusion have been studied globally, in Sub-Sahara Africa and across Africa. They have also been studied in Ghana and the study area. Rogers' (2003) adoption theory stands out globally and it serves as a yardstick for measuring various adoption models. There is however a research gap in Rogers' (2003) theory because he did not give a specific time frame within which an innovation should generate a normal adoption curve. The adoption studies across Africa show contrasting results due to several factors. Among them include differences in geographical location, technological factors, socio-economic and socio-demographic characteristics of the adopters.

The average adoption rate of NERICA in Ghana as at 2010 was 3% while the specific adoption rate in the study area was 1%. The adoption studies conducted by Asuming-Brempong *et al* (2011) showed an adoption gap of 44%. However, their study was not NERICA specific since it included other improved rice varieties in the study area. Besides, their potential adoption rate of 91% of NERICA in the study area had no time limit. Hence, there was a research gap in their prediction, which needs to be addressed.

The empirical evidence showed that a combination of individual, group and mass extension teaching methods, which are considered effective innovation dissemination methods, were used to introduce NERICA to rice farmers in the study area. It also showed that rice was a staple food in Ghana, and for that matter the study area.

It means the place of NERICA on the Ghanaian menu cannot be overemphasized. Therefore, appropriate and effective innovation dissemination methods were necessary for the introduction of NERICA in the study area.

However, the adoption gaps in previous studies on the 'magic crop' need to be addressed to give the true picture of NERICA adoption in the study area and in Ghana. This study would therefore close the adoption gap in Rogers' (2003) adoption theory by stating the specific time frame during which an innovation would generate a normal curve. It would also address the research gap in Asuming-Brempong *et al* (2011) by indicating a particular time frame during which the potential adoption rate of NERICA would be reached. Finally, this research is NERICA specific and would state the actual and potential adoption rates of NERICA within a given time period. Hence, this study would improve upon previous research findings within and outside the study area.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter presents the profile of the study area and the methodology used for the study. The study area for this research is Tolon and Kumbungu Districts (formerly, Tolon-Kumbungu District) in the Northern Region of Ghana. Methodology is a framework for the research study, which comprises the research methods, procedures and tools for data collection and analysis in order to find answers or solution to research questions (Kumekpor, 2002). It is therefore absolutely necessary that a research methodology is properly designed and followed to obtain accurate and valid data for analysis and interpretation to answer the research questions and objectives.

3.2. Profile of the Study Area: Tolon and Kumbungu Districts

Tolon and Kumbungu Districts used to be one district (Tolon-Kumbungu District) until June 28, 2012. The two districts have since been autonomous with Tolon as the administrative capital of the Tolon District and Kumbungu as the capital of the Kumbungu District. These districts were chosen for the study because they were among the districts where NERICA was introduced to farmers in the Northern Region. Because the two districts have similar characteristics and they were one during the NERICA introduction period, data of the two districts were not properly delineated. They will be discussed together.

3.2.1. Location and Size

The Tolon/Kumbungu district lies between latitude 9^0 16' and 9^0 34' North and longitudes 0^0 36' and 0^0 57' west (https://en.wikipedia.org). The land area of the two

districts is 2,400km^2 of which 70% is arable and therefore has potential for agricultural purposes, especially production of cereal crops like rice (www.ghanadistricts.com).

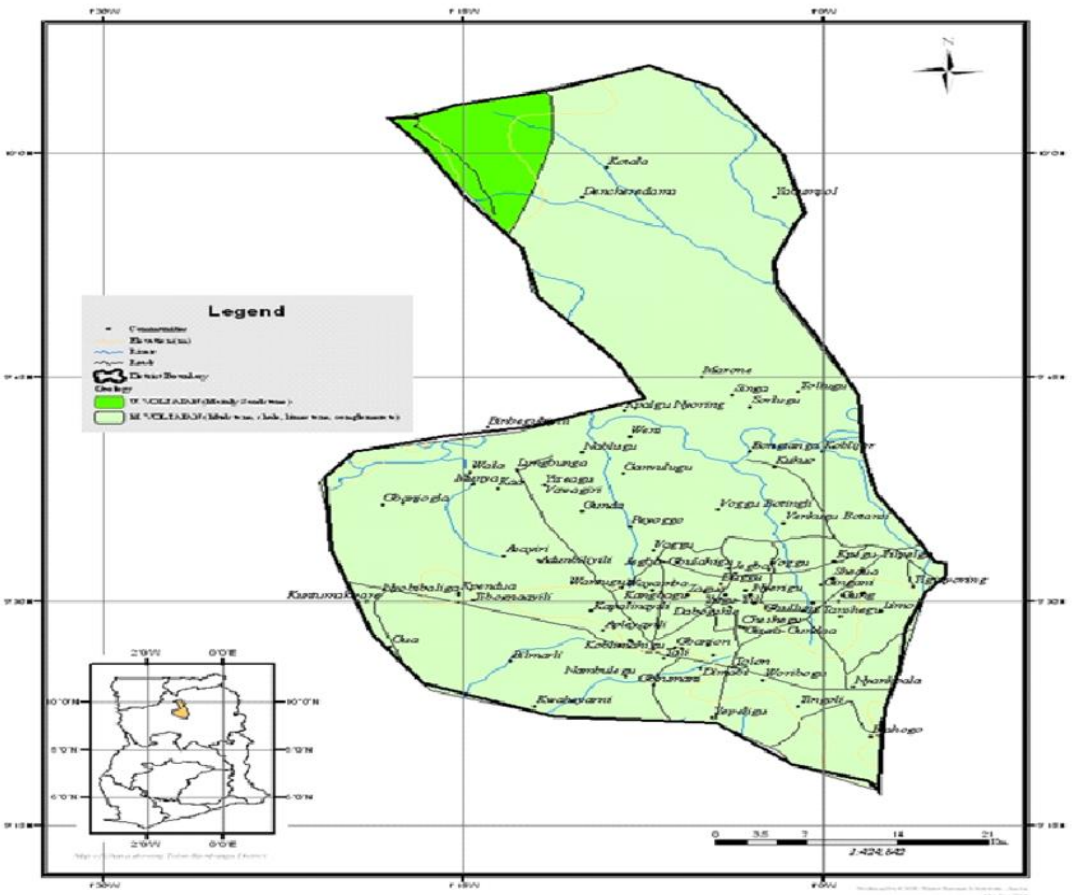

Figure 3.1: Map of Tolon and Kumbungu Districts
Source: https://www.google.com.gh/search, 2017

The Tolon District shares borders with North Gonja (Daboya District) to the west Kumbungu District to the north, Central Gonja to the south and to the east with Tamale Metropolitan (www.ghanadistricts.com). The Kumbungu District also shares boundaries with Savelugu-Nanton Municipal to the east, Tolon District to the south, North Gonja District to the west, and to the north with Mamprugo/Moaduri District respectively (www.ghanadistricts.com).

3.2.2. Demography

According to the Population and Housing Census of 2010, the total human population of the Tolon/Kumbungu District stands at 112,331 comprising 56,046 males and 56,285 females (Ghana Statistical Service [GSS], 2012). The total figure constitutes 4.5% of the total population of the Northern Region (Nyarko, 2012).

The total population of the Tolon District is 72,990. Males constitute 36,360 and females, 36, 630 (GSS, 2013). The total population of the Kumbungu District is 39,341. The number of males (19,686) is slightly higher than the females (19,655) (Ghana Statistical Service [GSS], 2013). The entire population of the district is classified as rural because all the settlements with 5,000 people or more is considered urban; otherwise it is rural (Ghana Statistical Service [GSS], 2013).

3.2.3. Climate and Vegetation

The local climate has only one cropping season in a year, usually from May to October is considered as the wet season. However, there are irrigation dams at Golinga and Botanga for cultivation of rice twice a year (www.ghanadisctricts.com). The dry season normally starts from November to April each year. The annual relative humidity ranges from 65-85%, but can be as low as 10% during the dry Harmattan period. Average temperatures range from 22-40 degrees Celsius, whereas annual rainfall is 1,000 millimetres and often unevenly distributed and erratic during the cropping season, thus posing a challenge to crop production and food security in the district (Indian Council of Agricultural Research [ICAR], 2006; MoFA, 2010). So the weather fluctuates in the study area.

In 2009, the weather was very cool and wet. There was appreciable rise in the rainfall figures causing flooding of about 2,700 acres of farm land across the study area. The period recorded a value of 1,282mm with 68 wet days as against 1,67.5mm with 74 wet days in 2008 (Ministry of Food and Agriculture [MoFA], 2009). In 2011, the area experienced generally low rainfall situation recording a total rainfall of 1,074mm with 63 wet days as against 1,298mm with 81 wet days recorded in 2010 (Ministry of Food and Agriculture [MoFA], 2011). The rainfall distribution was described as below normal for 2011, which accounted for low yields of crops because the rains began late and stopped early.

The vegetation is dominated by local tree species such as dawadawa (*Parkia biglobosa*) and shea nut (*Vitellaria paradoxa*). Exotic plant species such as mango (*Magnifera indica*), and neem are also commonly found around the settlements.

3.2.4. Topography, Soil and Drainage

The districts are located 180 metres above sea level. The topography is generally undulating with shallow valleys that serve as stream courses and isolated hills. The districts are among the few in the Northern Region through which the Volta River pass. Other major natural water sources in these districts include Botanga, Golinga, Jaagbo, and Tolon dams. Many other smaller dams are also dotted around (Tolon-Kumbungu District Assembly, 2001).

The soils are generally sandy-loam, except in lowlands where there are alluvial deposits. Conditions of the soils therefore pose no limitation to crop root development, since the soils are well drained in most cases. The soils are however

sometimes low in nitrogen and organic matter (Donhauser *et al*, 1994). The soil conditions have been worsened in recent years by bush fires, continuous cropping on the same piece of land and the effects of climate change.

3.2.5. Agriculture

The land area of the Tolon and Kumbungu Districts is 2,400km^2 of which 70% is arable and therefore has potential for agricultural purposes, especially production of cereal crops like rice. More than 70% of the population of the Districts are engaged in one form of agricultural activity or the other (www.ghanadistrics.com).

The average holding per farm family is 6.7 acres (www.ghanadisctricts.com). The dominant farming systems are mono-cropping, smallholder mixed system (crop and livestock integrated) and limited agro-pastoral system (MoFA-DADU, 2007). Maize, rice sorghum, cassava, yam, groundnuts, cowpea, soybeans, pigeon pea, cotton, shea-nuts and various vegetables constitute the main cash and subsistence crops in the districts (GSS, 2013). Livestock reared include sheep, goats, cattle, local fowls (chicken), guinea fowls, and pigs, which are normally kept in a mixed farming system. They play an important role in the family's risk management strategy and provide a reliable source of income and food security. Sheep, cattle and goats are also used for socio-cultural purposes such as traditional festivals, funerals, and marriages (MoFA-DADU, 2007).

Agricultural Extension Officers in the two districts support and promote agriculture and work in collaboration with the University for Development Studies (UDS), Animal Research Institute (ARI), the Savannah Agricultural Research Institute

(SARI), relevant NGOs like World Vision International (WVI) and Adventist Development and Rural Agency (ADRA) as well as other development partners operating in the districts (www.ghanadisctricts.com).

3.2.6. Financial Institutions and Mass Media

There are two banks in the districts to facilitate farmers' access to credit and financial services. Bonzali Rural Bank at Kumbungu and Nyankpala, and Ghana National Bank in Tolon Township is very strategic for agricultural purposes. There is also Simli Radio at Dalung in the Kumbungu District that helps broadcast and disseminate agricultural innovations to farmers. In addition to these, all radio frequencies from Tamale (Bishara Radio, Fiila FM, Radio Justice, Diamond FM, Kesmi FM, and Radio Tamale, among other) can be accessed in the district. Besides, the national televisions (GTV, Metro TV, TV3 and TV Africa) and newspapers (Daily Graphic, Ghanaian Times, The Mirror and The Enquirer) are all accessible to inhabitants. Farmers who have access to multi television channels are able to get information from international TV stations.

Smallholder and women farmers in the districts benefit from agricultural programmes aimed at increasing their productivity and improving their incomes (Ghanadisctricts.com). The cumulative effect is sustainability of improved farming methods and food security.

3.2.7. Ethnicity and Economic Status

All the communities are dominated by Dagomba and interspersed with a few Frafra, Akan and Ewe. The communities are therefore no more homogeneous as they used

to be about two or three decades ago, due to inter-tribal marriage, urbanization, trade and agricultural related activities such as farming and fishing. Economically, the two districts are among the poorest in the region with majority of the people being peasant farmers living in scattered settlements with poor road networks (Ghanadistricts.com). Poverty is both a perception and a reality among many Ghanaians, especially Northerners (Martey *et al*, 2013; GSS, 2014).

3.3. Research Design

The choice of appropriate research design is very important in determining the quality of the outcomes of any research. Yin (1994) describes a research design as the logic that links the data to be collected and the conclusions to be drawn to the research questions. It deals with a logical problem to avoid a situation in which the evidence does not address the initial research questions, and hence maximises the validity and reliability of the research findings.

This study is oriented towards determining the adoption of NERICA as it exists now in the Tolon and Kumbungu districts. Hence, Brown's (1996) Non-Experimental Descriptive Survey Design was adopted for this study.

Survey research studies samples chosen from a population to ascertain the relationship between various variables (Asante, 2000; Osuala, 2001; Babbie, 2005). It analyzes the data from respondents in order to answer a hypothesis or describe a set of characteristics. The information collected covers issues ranging from attitudes, values, opinions, to description of past and present situations as well as incidents (Babbie, 2005; http://wwwfhs).

The researcher was interested in assessing various characteristics of people, through the study of samples drawn from a given sample frame. From this study, inferences about the population were determined. This survey did not actually provide solutions to the problem under study, but provided information for sound decisions.

Survey types are conveniently based on the different methods of obtaining information. Twumasi (2001), posits that the questionnaire type through personal interviews far outweighs the others as the most powerful and useful tool of social scientific research. Kwabena (2006) concurred with the above notion by further expatiating that the questionnaire is useful for eliciting information on specific problems from well classified informants, and its purpose is to collect and compare relevant data, minimize bias, and motivate respondents.

Questionnaire, interviews, focus group discussions and observations were used to gather information from the beneficiary farmers of the NRDP. Key informant interviews were used to verify the facts obtained from the farmers. The questionnaire was therefore designed in such a way that accurate information was easily cross-checked to determine the reliability of information. According to Nchor, (2011) open-ended and closed-ended questions are useful in eliciting information from farmers and agricultural agencies. Hence, the questionnaire used in survey had both open-ended and closed-ended questions.

Key informants such as opinion leaders, staffs of SARI and MoFA were interviewed to facilitate the collection of detailed information about the innovation. Secondary information relevant to the topic was also sourced from the project reports, journals,

the internet and other publications to support the primary data. In order to obtain very reliable and valid research findings, this study adopted both qualitative and quantitative research methods. Quantitative research is concerned with numbers whereas quantitative research is concerned with meanings. The choice between the approaches has long been a key issue in social science research (Laws *et al*, 2003; Seidu, 2011; Bhattacherjee, 2012). Though both approaches are derived from different philosophies; they are useful tools of research that can complement each other to provide insights into human behaviour (Osuala, 2001; Laws *et al*, 2003; Babbie, 2005). This study therefore used a complementary and mix approaches to collect, triangulate and analyse the research data.

3.4. Sampling and Sampling Procedure

The concept of sampling is very fundamental in conducting quantitative research and surveys, except when a complete census is required. Generalization can then be made about the population, based on the sample (Osuala, 2001). Beside financial and time constraints, there is usually no need to cover the whole population. It is therefore necessary to select a representative sample or units from which results of the analysis are extended or generalized for the population. Yet, in so doing care needs be taken to ensure that the sample is practically representative of its target population, so as to provide valid outcomes (Kumekpor, 2002).

According to Krejcie and Morgan (1970), there are various formulas for calculating the required sample size based upon whether the data collected is to be of a categorical or quantitative nature. To avoid the use of formulas, an appropriate sample size can be determined from a table, based on the populations and the

required margins of error. It is also possible to divide the population into sub-groups and treat each sub-group as a population. The table can then be used to determine the recommended sample size for each sub-group. Stratified random sampling technique can also be used, within each sub-group, to select the specific individuals to be included in the sample. For Krejcie and Morgan (1970), using the table is much simpler than employing a formula. They advocate the use of small but appropriate sample sizes, based on the table.

Laws *et al* (2003) and Osuala (2001) argue that using a sample that is too large is a waste of resources whereas too small a sample will yield invalid results. It means that a sample size should be moderate enough to provide valid information for generalization. Nchor (2011) indicates that an adequate sample size is determined by the nature of the population, the type of sampling design, the purpose of the investigation, the size of the population and time available. Another factor worth considering is the materials and financial resources at the disposal of the researcher. These factors were therefore considered in determining the sample size and sampling procedure for this research. Since, Brown's (1996) Non-Experimental Descriptive Survey Design was adopted for this study, Yamane (1967), formula [n = N/1+N (∞^2)] was considered very appropriate in determining the specific sample size from the population of 6,888 NERICA farmers in the two districts. Yamane (1967), formula was chosen over that of Krejcie and Morgan (1970), because it gives the exact sample size to be taken from the population while Krejcie and Morgan (1970) estimate the required sample size for convenience's sake. Since the total population of farmers was known, it was more appropriate using the Yamane (1967) formula to obtain the precise sample size for this study.

3.4.1. Population and Sample Size

The total number of farmers involved in the project was 6,888, comprising 375 Seed Producers (SP) and 6,514 Grain Producers (GP). About 81.2% of the farmers were males and 18.8% were females. They worked with 16 Agricultural Extension Agents in 16 operational areas within the districts (8 operational area and 8 AEAs per district). Each AEA was therefore assigned to an operational area with its corresponding communities. A sample was taken for the study, based on Yamane's (1967) formula:

$n = N/1+N (\infty^2)$

Where;

N = Total population

n = Sample size

∞ = Alpha margin of error (0.05^2)

By using the above formula, the sample size of 378 NERICA farmers was obtained for this study as follows: $n = N/1+N (\infty^2)$; $n = 6,888/1+6,888 (0.0025) = 6888/18.22 = 378$. Purposive sampling was used to select 5 AEAs, due to their technical knowledge in Agricultural Extension Services and involvement in the NRDP.

3.4.2. Sampling Procedure

Random, purposive and proportional stratified sampling techniques were used to obtain the sample for the study, as shown in Table 3.1.

Table 3.1: Sampling Procedure

Process	Activity	Results
1	Obtaining the sampling frame of NERICA Operational Areas from the Tolon and Kumbungu District Directorates of Agriculture	16 NERICA Operational Areas; 6,888 NERICA farmers
2	*Random* sampling of NERICA Operational Areas from the two districts (2 Operational Areas from each district)	4 NERICA Operational Areas, 5 AEAs
3	*Random* sampling of NERICA Communities in each operational area (averagely, 4 communities per operational area).	16 NERICA Communities
4	*Proportional* sampling of NERICA farmers per community (based on the percentages and total number of farmers per community in Table 3.2) to represent the total sample	378 out of 6,888 NERICA farmers
5	*Proportional* stratified sampling of men and women NERICA farmers in each selected operational area.	72 women and 306 men (Ratio: 1:4)

Source: Field Survey, 2015

A Multi-stage stratified random sampling was used to select the operational areas, communities and farmers for the study. In the first stage, a list of all (sampling frame) the NERICA Operational Areas was obtained from the Tolon and Kumbungu District Directorates of Agriculture (DDA).

The second stage involved random sampling of four NERICA Operational Areas in the two districts (two in each district): Golinga and Nyankpala (in the Tolon District), as well as Gbulung and Kumbungu Kukuo (in the Kumbungu District). There was only one AEA per operational area.

The third stage of the sampling process was the selection of NERICA Communities from each Operational Area. The NERICA communities in each operational area were then randomly selected for the study. In all, sixteen NERICA communities were selected to represent the sixteen operational areas as indicated in Table 3.2.

The fourth stage of the sampling process was the proportional sampling of NERICA farmers per community (based on the total number of farmers per community) to

represent the total sample of 378 farmers from the entire population. The percentage of farmers per community in the population was used to determine the percentage and number of farmers per community for the sample. Though the project staff referred to some farmers as 'seed producers' and others as 'grain producers,' that distinction was not clear at the community level. So, all the farmers were simply referred to as 'NERICA farmers'. A head count of all the NERICA farmers (obtained from the sample frame) resulted in the figure 6,888. This study therefore did not separate the seed producers from the gain producers.

Table 3.2: Numbers and Percentages of NERICA Farmers per Community

Community	Number of Farmers	Sample size	Percentage
Kpachi	234	13	3.4
Tuunaayili	289	16	4.2
Kukuonaayili	227	12	3.3
Kpana/Gawugu	379	21	5.5
Dasuyili	289	16	4.2
Tingoli	296	17	4.3
Naha	434	24	6.3
Galenpkegu	847	44	12.3
Nafarun	296	17	4.3
Nyanpkala Islamia	510	28	7.4
Golinga	489	27	7.1
Gbulahagu	310	17	4.5
Gbullung	730	40	10.6
Kumbungu Kukuo	620	34	9.0
Jangirigu	434	24	6.3
Tignyorun	517	29	7.5
Total	6888	378	100

Source: Field Survey, 2015

The fifth stage of sampling involved a *proportional* stratified sampling of men and women NERICA farmers in each selected operational area. Since 81.2% of the farmers were males and 18.8% were females, a *proportional* stratified sampling technique (81% males and 19% females) was used to select the respondents from each operational area. In all, 72 women and 306 men farmers were proportionally selected, so as to give each sex a fair representation in the total sample. Thus, the ratio of men to women in the sample was 4:1.

3.5. Data Collection

Primary data was collected using the research instruments discussed above. Studying and reviewing relevant documents for secondary information to support other sources of data is an essential necessity in social and scientific research (Laws *et al*, 2003). The researcher needs to know about prior research related to his or her research issues and also orient him or herself to the field situation and methods of research investigation. Hence, one needs to consult and read extensively on existing literature. For Twumasi (2001), the researcher needs to review relevant literature of past and present works, official reports, statistical data, and many related writings in the course of the research to help ideas of the work. This study therefore reviewed NERICA project reports and relevant literature on adoption of agricultural innovations to help understand and interpret the primary data.

3.6. Research Instruments: Questionnaire and Interview Guide

Questionnaire: A questionnaire is one of the main instruments and tools used in survey research. It is a set of questions that have been structured with the sole aim of collecting information on specific problems from knowledgeable informants, who

are expected to answer in writing either by the respondent or the researcher (in the case of illiterate respondents) (Kwabena, 2006). Law *et al* (1998), argue that questionnaire is efficient and useful research method on the grounds that it enables collection of information from a large number of respondents who are geographically scattered and a relatively cheaper method. It enables the researcher to collect information about respondents' internal meanings and ways of thinking about the issues at stake. Besides, it protects the privacy of respondents and the confidentiality of their information, thereby ensuring honesty in their responses.

This study relied on questionnaire as its main research instrument. Personal interview questionnaire (Appendix 'A') was accordingly administered to three hundred and seventy-eight (378) rice farmers in the two districts.

The questionnaire was made up of closed and open-ended questions written in simple language for easy understanding of farmers. There were 49 questions in all divided into five sections. Each section addressed a specific objective of the study. The first 12 questions, based on the socio-economic characteristics of the farmers, constituted section one; section two was made up of the next 5 questions in the series, which looked at the innovation dissemination methods used in the districts; section three was on the adoption of NERICA and had 13 questions (18 to 30). Section four was the longest section, which elicited responses from farmers on the factors that affected adoption of NERICA in Tolon and Kumbungu Districts. It had 16 questions in all, starting from questions 31 to 46. The fifth and final section was captioned, 'Challenges and Prospects of NERICA Adaption' and it had 3 questions, which were questions 47, 48 and 49.

There were 7 tables in the questionnaire, each of which had a set of questions. All the sections had at least a table except sections one and four. Section two had 2

tables, which can be found at questions 15 and 17. Section three had 4 tables located at questions 19, 20, 23 and 29. The last table can be found at question 48 and fell within section five of the questionnaire.

Interview guide: This is a list of questions, often referred to as check list, which serves as a guide for the interviewer to remain on course (Lamptey, 2006; Twumasi, 2001). With the guide in place, the interviewer is able to elicit various responses from the target audience to drive home the point for discussion. When a particular item on the guide has been adequately dealt with, the interviewer ticks that item and moves to the next item until all the items on the list are covered (Lamptey, 2006; Osuala, 2001).

The interviewer wrote down the key findings in the responses, with the consent of the interviewee. Confidentiality was assured and the issues were clarified to avoid misrepresentation of facts. The interviewer also engaged a third person to record the interview so as to save time and help verify the key facts written down, as proposed by Osuala, (2001), Twumasi, (2001) and Kwabena, (2006). That enabled the interviewer to focus on the questions and also jot down some salient points emanating from the responses for further questioning. Where confidentiality was assured but the interviewee did not want a third party to be part of the discourse in recording the interview, the interviewer combined the questioning and recording all by himself.

The researcher scheduled convenient times and places for farmers who could not answer the personal interview questionnaire, due to illiteracy. The researcher made use of two interpreters, one from the study area and the other from outside the study

area. Farmers were assured of confidentiality and were given the option to choose which of the interpreters they preferred to be a third party of the discourse. Most of them preferred the interpreter from the community because they were familiar with him and also for the fact that he was conversant with the project and worldview of the farmers. The interview guide (Appendix 'B') contained ten key questions based on the research objectives. The researcher personally asked the questions systematically and probed further to elicit the same responses as contained in the personal interview questionnaire and wrote the appropriate responses on paper.

3.7. Data Collection Methods

Accurate and reliable data are essential in solving scientific problems. In social science research, methods such as questionnaire, interviews, documentary sources, observations, case studies, life histories and focus group discussions can be used to collect data. The choice of a particular method however depends on the nature of the research problem, the type of people to be encountered, the nature of the social situation and the skills of the researcher. To obtain valid and reliable, data, it is essential to use more than one method, preferably, a combination of methods in order to blend the strengths and weaknesses of the various methods employed (Twumasi, 2001; Osuala, 2001). During data collection, researchers are often faced with the problem of obtaining the right amount and level of detail of data relevant to the research objectives. Under such situations, Osuala (2001) and Twumasi (2001) argue for the application of the principle of 'optimal ignorance' in survey research to guide the amount and quality of data to be collected, on the grounds that time of respondents is always limited and need not be wasted.

This research applied mixed data collection methods and triangulation of the methods in the context of optimal ignorance to achieve quality data by employing interviews, observations, focus group discussions and key informant interviews as its main research methods.

3.7.1. Interviews

Fianu (2006) defined interview as a two-person conversation initiated by the interviewer for the specific purpose of obtaining research-relevant information. Interview enables the researcher to interact with respondents by asking planned sequence of questions and recording the responses accordingly. According to Kumekpor (2002), the interview method of data collection is very useful because it provides immediate feedback to the researcher for cross-checking of data in a relaxed atmosphere. It is also a very suitable instrument for collecting data from rural and illiterate folks, and it allows individual respondents to tell their story in their own way. Besides, interview is a quick way of gathering survey data. Instead of asking people to answer formal and 'controlled' type of questions and write down their responses as in self-administered questionnaire, the researcher in this case asks the questions orally based on the subject matter and then records the responses. Other emerging issues could be clarified immediately. The respondents also have the freedom to answer to questions the way they feel, know best or deem fit. For Twumasi (2001), the advantage of interviews is that it has a high response rate, since respondents would normally feel reluctant to turn down the interviewer standing by their door posts. That is true because in Africa and for that matter Ghana, where people tend to be accommodating and polite even at their own inconvenience, it becomes very difficult for respondents to tell a researcher straight in the face that

they would not like to grant the interview. For Fianu (2004), when using interview, people are likely to give wrong information despite its advantages. However, when the researcher creates good rapport with the potential respondents and approaches them in an appropriate manner at a convenient time, responses are most likely to be reliable, especially when confidentiality is assured.

There are two types of interviews; structure and unstructured interviews. Structured interviews use a strict procedure and a guide to obtain precise information, whereas unstructured interviews use no strict procedures or protocol, thereby allowing flexibility, open-ended discussions and spontaneous responses (Twumasi, 2001; Kumekpor, 2002).

Unstructured interviews were used in this study to elicit detailed information from key informants to clarify and enhance data gathered from the questionnaires. Structured interviews were done at the community level using the interview guide and targeting heads of farm families and leaders of the NERICA farmers. The study made use of experienced interpreters with good knowledge of the local language, culture and the subject matter who interpreted the questions to the farmers for effective communication and collection of quality information from respondents.

3.7.2. Observation

Observation plays a key role in all research. Direct observation of participants in their natural settings enables the researcher to collect additional information and to check whether what the participants think, say or do is reflected in their actual behaviour (Laws *et al*, 2003).

Observations are of two main types; participant and non-participant observations. Participant observation is where the researcher goes to live with and participate in the activities of the people he or she is studying, observes and gets insights of the situation for answers to the research questions (Twumasi, 2001). Non-participant, observation on the other hand, is where the researcher is physically present only as a spectator rather than an actor and does not become directly involved in the activities of the people being studied. He or she remains socially isolated from the group, yet carefully notes and records issues of interest to the topic (Kumekpor, 2002).

Observation method is relatively inexpensive, less time consuming, yields more objective data, and it permits collection of a wide range of data while approaching reality in its natural state (Twumasi, 2001; Kumekpor, 2002). However, because people tend to be skeptical and suspicious of strangers in their midst, they tend to put up face and performances, which can influence the researcher's observations. The reason being that they would try to be 'careful' with their speeches and actions in order not to wash their dirty linen in public, especially when dealing with strangers. So information from non-participant observation becomes very reliable when gathered without the conscious awareness of those being observed because it could be an ethical issue. Similarly, data from participant observation would be more reliable when the researcher gains trust and confidence of those being observed and might have more or less become like one of them. That takes quite a long time to achieve. Hence, whether participant or non-participant observation, the researchers should not give the audience cause to suspect being observed.

Non-Participant observations were made in the communities, especially on markets gatherings, cultural occasions, funerals, rice mills and popular food joints to obtain

additional information for the research questions and issues. The researcher was physically present at such gatherings to ask questions and to see at first hand the extent to which NERICA was patronized and used, especially in dishes in the study area. The researcher also observed the farmers farms, grain barns as well as gestures and mannerisms of farmers during interviews, questionnaire administration and focus group discussions to deduce the authenticity of the data being gathered. Such information was helpful in clarifying the extent of adoption within and without the two districts.

3.7.3. Focus Group Discussion

Focus group discussion (FGD) is a rapid assessment, semi-structured data gathering method in which a purposively selected set of participants gather to discuss issues and concerns based on a list of key themes drawn up by the researcher/facilitator (Kumar, 1987). A focus group can therefore be considered as a small group of six to ten people led through an open discussion by a skilled moderator. The group needs to be large enough to generate rich discussion but not so large that some participants are left out. The focus group discussion has become extremely popular in survey research because it provides a fast way to learn from the target audience (Debus, 1988; US Department of Health and Human Services, 1980). In agriculture, focus groups have been used to obtain insights into target audience perceptions, needs, problems, beliefs, and reasons for certain practices (Debus, 1988).

A focus group discussion was used to gather information from the respondents during the study (Appendix 'C'). Before the focus group discussion began, the researcher obtained the background information of participants such as their age,

crops grown and farm size. After a brief introduction, the purpose and scope of the discussion were explained to the participants. The discussion was based on the research topic using probing questions prepared in advance. All participants were given the opportunity to participate in the discussion and a variety of moderating tactics were used to facilitate the groups.

One FGD was held in each community for farmers who answered the questionnaire interview questions. Nyankpala Islamia group had the largest number of eight participants while Jangirigu group comprised six participants. The other communities had seven participants per group. Generally, the participants comprised a leader, two secretaries and four members of the NERICA farmers' groups in each community. The findings from the FGDs helped the researcher to gain insight and clarify data obtained from the questionnaire.

3.7.4. Key Informant Interviews

The term "key informant" refers to anyone who can provide detailed information and opinion based on his or her knowledge of a particular issue and seeks qualitative information that can be narrated and cross checked with qualitative data. This method of data collection is known as "triangulation" (Law *et al*, 1998). SARI and MOFA staffs were the key informants for this study.

The researcher had informal interactions on regular basis before, during and after administration of the questionnaire to verify non-participant observations made in the communities and also to clarify certain assertions made by the farmers. The researcher also asked salient questions about the facts and figures obtained from the project reports presented to donors and the government of Ghana. The researcher

posed the same questions to MOFA and SARI staff on different occasions and at different locations in the context of optimal ignorance to authenticate the findings. The key informant interviews, in most cases, confirmed the findings from the questionnaire and the observations made in the field. A typical example was the market price of NERICA, which the farmers said was not very different from those of other rice varieties in the study area. When in doubt, the researcher contacted the project managers and the District Directors of MOFA for the price list of all rice varieties within the study area from 2006 to 2014 and it became evident that the market prices of NERICA were similar to those of the other rice varieties.

3.7.5. Stages of Data Collection

The study was conducted in two phases comprising reconnaissance survey and main survey. During the main survey, data was collected from three hundred and seventy-eight rice farmers on the adoption of NERICA in the Tolon and Kumbungu Districts.

(a) Reconnaissance Survey

Preliminary visits were made to the study area for acquaintance and familiarization with the geographical, agro-ecological and social settings, cultural and agricultural issues as well as formal and traditional institutional structures. That led to the establishment of rapport, contacts and relationships with key stakeholders at the institutional and community levels. Individual technical and contact persons were identified at the MoFA, SARI and UDS and in the communities to facilitate subsequent interactions and field research activities. Secondary information for the study was as collected during this phase.

(b) Main Survey

The researcher personally administered the questionnaire to the NERICA farmers, with the help of two interpreters. No questionnaire was administered to rice farmers outside the sample frame obtained from MoFA.

3.8. Methods of Data Analysis

The field data was processed and interpreted. The results were incorporated in the final report to complete the research. The data was critically analysed to determine the final outcome. Osuala (2001) refers to this technique as the ordering and breaking down of data into constituent parts using qualitative techniques and statistical calculations to provide answers to the research questions and problem. For Twumasi (2001), data analysis is a continuous process involving editing, coding and computer processing, each stage requiring asking of questions related to the research objectives in order to obtain meaningful answers.

This study used a combination of qualitative and quantitative methods to analyse the data, by employing Statistical Package for Social Science (SPSS). That generated all the necessary tables, charts, descriptive statistics (frequency and percentages) from which the survey results were interpreted. The qualitative data was mainly in the form of narratives and explanations, which helped to describe the information, generated from the SPSS in much detail and made real meanings out of them.

At the same time, data gathered from the FGDs, interviews and key informant stories on the research issues were analysed on a daily basis in the data collection process, which helped to clarify issues and ensure consistent and systematic work. The analyzed qualitative and quantitative data and information processed provided the

basis for making interpretations, inferences, deductions and meanings to address the research objectives and questions for the final work.

Hence, the first research objective (assessing the methods used to disseminate NERICA in the Tolon and Kumbungu Districts) was measured on the nominal scale and analysed by explanation. The second objective (finding out the adoption rates of NERICA in the study area) was also measured on the ordinal scale and analysed in percentages, using descriptive statistics. The factors that affected adoption of the innovation among the rice farmers in the districts were then measured on the categorical scale and analysed by regression. The regression analysis was mainly done on the socioeconomic characteristics of respondents that affected adoption of NERICA while the other factors were analysed in percentages using descriptive statistics. Finally, the challenges and prospects of NERICA adoption in the districts were measured on the ordinal scale and analysed in percentages, using descriptive statistics.

3.8.1. Logistic Regression Analysis Procedure

Regression is a statistical tool used to predict the value of one continuous variable from one or more other variables (DeCoster, 2004). Regression Analysis is a multivariate statistical methodology to investigate relationships and predict outcomes. One type of regression analysis is the logistic regression. Logistic regression is appropriate when the predicted outcome is binary (on/off, pass/fail, infected/not infected, etc.). Some logistic regression techniques resolve inconsistencies associated with dichotomous dependent data and the assumptions of ordinary sum of squares regression methods (http://www.en.wikipedia.org;

DeCoster, 2004). The independent variables that are used for outcome prediction may be dichotomous, categorical or continuous. Logistic regression is commonly used in manufacturing and health related studies (http://www.en.wikipedia.org; DeCoster, 2004). It can be used for any application where binary outcomes can be predicted. Logistic regression is based on the logit transformation of the dependent variable, which generates a continuous logarithmic curve from non-continuous data so that a regression model can be developed. The outcome probabilities for each dependent variable value are the basis for the model. The logit transformation is necessary since dichotomous dependent data violates ordinary least squares assumptions. Another issue with dichotomous data is that the error terms are not normally distributed, thus ordinary sum of squares regression and all normality tests are invalid (http://www.en.wikipedia.org; DeCoster, 2004).

In logistic regression, a complex formula is required to convert back and forth from the logistic equation to the OLS-type equation. The logistic formulas are stated in terms of the probability that Y = 1, which is referred to as ˆp. The probability that Y is 0 is 1 - ˆp.

$$In(p/1\text{-}p) = \beta 0 + \beta 1X \text{ ..... (1)}$$

The *ln* symbol refers to a natural logarithm and $\beta 0 + \beta 1X$ is our familiar equation for the regression line. *P* can be computed from the regression equation also. So, if we know the regression equation, we could, theoretically, calculate the expected probability that Y = 1 for a given value of X by;

$$P = exp(\beta 0 + \beta 1X)/\ 1\text{-}exp(\beta 0 + \beta 1X) \text{..... (2)}$$

exp is the exponent function, sometimes written as *e*. So, the equation on the right is just the same thing but replacing exp with *e*.

Model Assumptions

Logistic regression does not assume a linear relationship between the dependent and independent variables. The dependent variable does not need to be normally distributed. There is no homogeneity of variance assumption. In other words, the variances do not have to be the same within categories, normally distributed error terms are not assumed and the independent variables do not have to be interval or unbounded (http://www.en.wikipedia.org; DeCoster, 2004).

Model Specification

Since we fit a logistic regression model, we assume that the relationships between the independent variables and the logits are equal for all logits. The regression coefficients are the coefficients α, β1, β2,., βp of the equation:

Logit $[\pi(x)] = \alpha + \beta 1X1 + 2X2 + \ldots\ldots\ldots\ldots + \beta pXp$..... (3)

The results would therefore be a set of parallel lines for each category of the outcome variables. This assumption can be checked by allowing the coefficients to vary, estimating them and determining if they are all equal. So our maximum likelihood parameter estimates, diagnostic and goodness of fit statistics, residuals and odds ratios will be obtained from the final fitted logistic regression model (http://www.en.wikipedia.org; DeCoster, 2004).

3.8.2. NERICA Adoption Model

The dependent variable in this model is adoption. The Wald Chi-square (F- statistic) is the parameter of determining whether an independent variable is significant or insignificant. A probability of 0.00 indicates that Wald Chi-square is significant and this means that the independent variables jointly influence farmers' decision to adopt

NERICA. The Pseudo R-squared (R^2) indicates the variation in the probability of adoption explained by the factors used for the study. The other variations are explained by other factors.

The key factors that affected NERICA adoption are represented mathematically as,

Y= *f* (X1, X2, X3, X4, X5, X6, X7)

Where;

Y = Adoption of NERICA (Yes = 1; No =0) (Dependent Variable)

X = Factors affecting adoption of NERICA (Independent Variables)

X1 = Age of farmer (In years; Categorical)

X2 = Marital status (Dummy: Married =1; Not married = 0)

X3 = Level of education (In years; Categorical)

X4 = Years of experience in rice cultivation (In years; Categorical)

X5 = Household size of farmer (In ranges; Categorical)

X6 = Primary occupation of farmer (Dummy: Rice = 1; Other = 0)

X7 = Think NERICA is better than others (Dummy: Yes = 1; No = 0)

3.9. Conclusions on the Research Methodology

The study was carried out in the Tolon and Kumbungu Districts in the Northern Region of Ghana. Brown's (1996) Non-Experimental Descriptive Survey Design was adopted for this study. Yamane's (1967) formula was used to obtain a sample size of 378 from a population of 6888 NERICA farmers for this study. A Multi-stage stratified random sampling technique was used to select the operational areas, communities and farmers for the study. Questionnaire and interview guides were the

main research instruments. Interviews, observations, key informant interviews and focus group discussions were used as research methods to obtain both qualitative and quantitative data. The data was accordingly analysed and interpreted using descriptive and inferential statistics. The dependent variable in this research was adoption while farmers' age, marital status, household size, primary occupations, level of education, years of experience in rice farming and whether they thought NERICA was better than other rice varieties in the study area were the independent variables.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1. Introduction

This chapter presents the analysis of data taken from the 378 NERICA farmers in the Tolon and Kumbungu Districts and discussion of the results. The chapter is sub-divided into socio-economic characteristics of rice farmers, innovation dissemination methods used to introduce NERICA to farmers in the study area, adoption of NERICA, factors affecting adoption of the innovation among rice farmers, and challenges and prospects of NERICA adoption in the districts.

4.2 Socio-economic Characteristics of NERICA Farmers

This sub-section presents the socio-economic characteristics of NERICA farmers. It considers sex and educational level of NERICA farmers, age and marital status of respondents, occupations of respondents, educational level and household size of rice farmers, age and farmers' years of experience in cultivating rice, as well as educational level and farmers' primary occupation.

4.2.1. Sex and Educational Level of NERICA Farmers

The ratio of farmers who had no formal education was about 4 male to 1 female, which follows the pattern of the sample. Among the 51 farmers who had non-formal education, 30 were males and 21 were females. That seems to suggest that there was no much difference between the male and female farmers who had non-formal education in the project. All the farmers who had completed middle (MSLC) (54) were males, which seems to be in consonance with Martey *et al's* (2013), assertion

that females are normally occupied with domestic activities such that they do not have enough time to participate in Rice Development Projects (RDP) compared to their male counterparts. Only 1 male farmer (0.3%) had college (tertiary) education, which suggests that the very few educated male famers in the study area were SHS graduates, as indicated in Table 4.1. The low levels of educational achievements among farmers in the study area mean that a lot of education would be required to introduce agricultural innovations to the farmers.

Table 4.1: Sex and Educational Level of Rice Farmers

Educational Level	Sex of Farmer					
	Male		***Female***		***Total***	
	Freq	*%*	*Freq*	*%*	*Freq*	*%*
No formal education	169	44.7	49	13.0	218	57.7
Non-formal education	30	7.9	21	5.6	51	13.5
Primary/elementary	8	2.1	3	0.9	11	2.9
JHS	11	2.9	0	0	11	2.9
MSLC	34	11.3	0	0	34	9.0
Arabic	30	7.9	3	0.9	33	8.7
SHS	18	4.8	1	0.3	19	5.0
Teacher/nursing training college	1	0.3	0	0	1	0.3
Total	*301*	*80.0*	*77*	*20.0*	***378***	***100***

Source: Field Survey, 2015

The findings on sex and educational levels of the farmers revealed that about two thirds of the farmers had no formal education. That is not surprising because it is a characteristic of rural communities, such as the study area. Education is very important to adoption. Umunna (2010) opines that education permits an individual to control the rate of message input and develop the ability to store and retrieve information for later use. Weir and Knight (2000) also confirms the fact that extension officers find it more convenient in introducing agricultural innovations to

educated farmers than those without formal education. As Apusigah (2004) asserted, gender constitutes the entire ambit of relations that govern the social, cultural and economic exchanges between women and men in different facets of life. Mehta and Srinivasan (2000) also collaborate the view that gender is central to how societies assign roles, responsibilities, resources and rights between men and women.

4.2.2. Age and Marital Status of Respondents

The field survey indicated that none of the respondents was either separated or widowed. The singles were 1.6%, the married were 97.8% and 0.6% were divorced. It means most of the farmers were married, as shown in Table 4.2.

Table 4.2: Age and Marital Status of Respondents

Age (years)	**Marital Status**						***Total***	
	Single		**Married**		**Divorced**			
	Freq	%	Freq	%	Freq	%	*Freq*	*%*
Below 30	5	1.3	19	5.0	0	0	*24*	*6.3*
30 - 39	1	0.3	81	21.4	0	0	*82*	*21.7*
40-49	0	0	75	19.8	0	0	*75*	*19.8*
50-59	0	0	123	32.5	1	0.3	*124*	*32.8*
60 and above	0	0	72	19.1	1	0.3	*73*	*19.4*
Total	*6*	*1.6*	*370*	97.8	*1*	*0.6*	***378***	***100***

Source: Field Survey, 2015

The highest number of farmers (32.8%) fell between the 50-59 age groups, and they were all married while the lowest number of farmers fell below the 30 year old bracket, most of whom were also married. These mean that both younger and older farmers in the study area value marriage.

A further enquiry during the interview revealed that marriage is a value in both districts in particular and Dagbon society in general. This is evident in the results from the study as larger families and family members including children served as labour for farm families in their family income generation and related activities.

4.2.3. Occupations of Respondents

Apart from the secondary occupations presented in Table 4.3, the other secondary occupations mentioned by the respondents are butcher, fishing, schooling, volunteer health promotion, wanzam and barbering. Crop farming was the main primary occupation of most (91.8%) of the respondents whereas animal rearing constituted the major secondary occupation (51.1%) of the farmers in the study area. Interestingly, almost all the respondents considered themselves as "farmers". According to them, there is no difference between crop farming and animal rearing. Respondents, who referred to themselves as farmers, implied that they were involved in both crop farming and animal rearing. So farming was the main occupation of the people in the study area.

It was revealed during the interviews that animal rearing is considered as a form of investment and the proceeds from the crops were used to buy and keep more animals. The residue served as food for their animals. In that way, the farmers made good use of both animal and crop products, by-products and residues. Animal dropping served as organic manure for their crop farms. The farmers therefore harnessed the advantages of mixed farming.

Table 4.3: Primary and Secondary Occupations of Respondents

Occupation	Primary		Secondary	
	Frequency	%	Frequency	%
Artisan	3	0.8	23	6.2
Crop farmer	347	91.8	25	6.6
Animal rearing	3	0.8	193	51.1
Trader	22	5.8	84	22.2
Groundnut processing	3	0.8	7	1.9
Salaried worker	0	0	10	2.7
Weaving	0	0	10	2.7
Other(s)	0	0	25	6.6
Total	378	100	378	100

Source: Field Survey, 2015

The interview responses showed that rice cultivation was not the main crop of some of the respondents. During focus group discussions, it was found that some of the farmers went into rice cultivation either to try the NERICA or simply as an alternative form of employment during the project period. Such farmers returned to their main occupations after the project period elapsed. It means some of the NERICA farmers were not rice farmers but people who participated in the project only to take advantage of the financial and material gains of the innovation. That is possible because many Ghanaians highly uphold group solidarity such that people are enlisted, recruited and admitted into groups, institutions and organizations, which they otherwise not qualify to be. That explains Rogers (2003), definition of the social system as a set of interrelated units engaged in joint problem solving to accomplish a common goal.

4.2.4. Age and Farmers' Years of Experience in Cultivating Rice

It is usual for the aged famers (60 years and above) to have more than 20 years experience in rice cultivation but unusual for younger farmers below 30 years to have more than 20 years experience in rice cultivation**.** However, the reverse seems to be the case of NERICA as could be gleaned from Table 4.4.

Table 4.4: Age and Farmers' Years of Experience in Cultivating Rice

Age (years)	**Farmers' Years of Experience in Cultivating Rice**						
	Below 5 Years	*6-10 Years*	*11-15 Years*	*16-20 Years*	*Above 20 Years*	*Total*	*%*
Below 30	5	28	8	5	0	46	12.2
30 - 39	12	78	45	15	22	172	45.5
40-49	3	54	21	20	26	124	32.8
50-59	0	7	8	3	8	26	6.9
60 and above	0	4	0	0	6	10	2.9
Total	*20*	*171*	*82*	*43*	*62*	*378*	*100*
Percentage	*5.3*	*45.2*	*21.7*	*11.4*	*16.4*	*100*	

Source: Field Survey, 2015

Results on Table 4.4 shows that five farmers who were less than 30 years old had about 20 years' experience in rice cultivation. That means they started cultivating rice when they were about 10 years old or they gave their wrong ages during the survey. That should be expected in rural communities where majority of the people are not highly educated. Children in such communities normally accompany their parents to the farm and serve as sources of family labours. Such children might have gained experience in rice cultivation by helping their parents on the farm.

On the other hand, only 4 of the aged farmers had about 10-15 years' experience in rice cultivation, which means such farmers, started cultivation rice around the time of the NRDP. Since the NRDP introduced the NERICA to existing rice farmers, it

presupposes that they were attracted to rice cultivation due to the potential benefits (relative advantages) of NERICA introduced to them.

About 6 of the aged farmers had more than twenty years' experience in rice cultivation. This means that they started growing rice when they were much younger and had taken to rice cultivation as their profession and stayed with it over the years. Such farmers are more likely to adopt an innovation and continue with it if convenient for them. This is because although the aged are more skeptical when it comes to adoption of innovations, those who do adopt are normally those who have the experience and the needed resource to do so. Other aged farmers simply stick to their experience and old ways of farming, which they normally consider as more reliable than new ideas being introduced to them by young professionals.

The survey report revealed that farmers in their productive years (between 30 and 49 years), who also had rich experience in rice cultivation, were involved in the NRDP. That implies farmers vigorously cultivate rice during their productive years.

About 94.3% of the farmers had more than five years' experience in rice cultivation, with 6-10 years (45.2% of the respondents) as the mode. However, majority of the farmers (55.5%) had less than ten years' experience in rice cultivation, meaning they were inexperienced in rice cultivation prior to the NRDP.

4.2.5. Educational Level and Household Size of Rice Farmers

The household sizes and educational levels of respondents are presented in Table 4.5. About 6.9% of the respondents had household sizes of 1-3, 29.6% had household sizes of 4-6, and 37.8% of them had household sizes of 7-9. Besides,

11.8% of the farmers had household sizes ranging from 10-12 while those of 13.8% were above 12. Since some of the respondents were single, there were one-man households among the farmers. Such farmers may have to depend on other sources of labour for their farming activities since family labour is very essential in the study area. Larger household sizes are characteristic of illiterate farmers and rural communities in the study area, whose primary and secondary occupations are farming, and who depend largely on family labour for their farming activities.

Table 4.5 further revealed that 79.8% of the farmers had no formal education, 15% had basic/elementary education, meaning the majority of the farmers were illiterates. The illiterates (79.8%) comprised farmers who had never been to any school at all, those who pursued non-formal education and those who learnt only Arabic. The total figures in each column and row helped to determine the number of farmers in each category and their corresponding percentages.

Table 4.5: Educational Level and Household Size of Rice Farmers

Educational Level	**Household Size**						**Educational Percentage**
	1-3	**4-6**	**7-9**	**10-12**	**Above 12**	***Total***	
No formal Education	15	95	118	31	42	*302*	79.8
Basic Education	8	8	21	12	8	*57*	15.0
Secondary Education	3	8	4	2	2	*19*	5.0
Tertiary Education	0	1	0	0	0	*1*	0.2
Total	*26*	*112*	*143*	*45*	*52*	*378*	100
Percentage House Size	*6.9*	*29.6*	*37.8*	*11.8*	*13.8*	*100*	

Source: Field Survey, 2015

A profile of the study area showed that Kumbungu was a rural district while Tolon was an urban district, due to difference in their populations (GSS, 2014) and their

average household sizes. The population of Tolon was higher than that of Kumbungu.

The average household sizes of the two districts were 9.0 and 9.5 persons for Tolon and Kumbungu respectively, giving an average of 9.3 while the average household size of the sampled farmers was 8.0 persons (GSS, 2014). These figures were both higher than the northern regional average of 7.8 and the national average of 4.5 persons (GSS, 2014). That was mainly due to the fact that the communities in the Northern Region, and for that matter, the study area, were agrarian and rural communities that depended heavily on family labour for their farming activities.

It presupposes that farmers in urbanized and elite communities have lower household sizes and they depend more on hired labour for their farming activities. Literate farmers in this study area had smaller household sizes and they preferred to send their children to school and hire farm hands. This power of education enables individuals to make independent choices and to act on the basis of the decision (Enete and Igbokwe, 2009; Southworth and Johnston, 1967; Schultz 1945 and Ofori, 1973).

On the other hand, both literate and illiterate farmers who possess the capacity to adopt the innovation might lack the necessary physical and financial strength for its physical accessibility. So they resort to borrowing from financial institutions to finance their farming operations. This view is implied in Martey *et al* (2013) position that access to credit serves as an incentive for farmers to increase their production and overcome the financial constraints in participating in development projects which also has a direct impact on their livelihoods.

4.2.6. Educational Level and Farmers' Primary Occupation

Result of the data analysis shows that famers who were artisans (3) had no formal education. Similarly, respondents who were primarily crop farmers (201) and traders (11) had no formal education. However, none of the respondents who had no formal education took animal rearing as their primary occupation. This is because such farmers considered animal rearing as their secondary occupation. This is also because the study focused on rice (crop) farmers and not animal rearers. The reverse would have been true if the study had targeted livestock farmers in the area.

For many people, their primary occupation is their main source of livelihood. It is very possible that one's primary occupation may not be one's main source of livelihood because as farmers' educational levels increase, they tend to choose white colour jobs as their main occupation and source of livelihood rather than farming. For such farmers, crop farming or animal rearing would be their hobby or supplementary sources of income and food.

In all, only 3 out of the 378 respondents, who had basic education, took animal rearing as their primary occupation. It means those farmers participated in the NRDP as their secondary source of occupations or food to supplement their family income and food supply. In the same way, the respondents who took groundnut processing as their primary occupation (3 females) had no formal education.

None of the literate farmers considered trading and groundnut processing as their primary occupation. That means educated people in the study area prefer white colour jobs to farming, trading, processing or menial jobs.

Only 2 of the respondents, who were second cycle graduates, considered trading as their primary occupation. The study revealed that those respondents were store operators (provision sellers and motor spare parts dealers) who also participated in the NRDP.

It means that almost all the respondents had crop farming as their primary occupation because the innovation was mainly introduced to rice farmers who also cultivated other crops.

4.2.7 Conclusions on Socio-Economic Characteristics of Farmers

The profile on the socio-Economic characteristics of farmers showed that the ratio of men and women in the study was 4:1 and that of farmers who had no formal education was also about 4 males to 1 female. The findings on sex and educational levels of the farmers revealed that about two thirds of the farmers had no formal education. The marital status of the farmers showed that both younger and older farmers in the study area value marriage. Crop farming and animal rearing were the main occupations of the people in the study area, who vigorously cultivate rice during their productive years. Both experienced and inexperienced farmers were involved in NRDP. They had larger household sizes because they depend largely on family labour for their farming activities. Farmers with higher educational levels choose white colour jobs as their main occupation and source of livelihood rather than farming.

4.3. Methods Used to Disseminate NERICA in the Study Area

The first objective of the study was to find out the methods used to disseminate NERICA to the farmers in the districts. This sub-section of the study looked at the

collaboration between SARI and MoFA during the NRDP, the years NERICA was introduced to farmers and the years they tried its cultivation, the innovation dissemination methods used to introduce NERICA to the farmers. The innovation dissemination methods are also known as extension teaching methods (Rathod, 2016). This session also discussed extension teaching methods that are still available to the farmers after the NRDP and found out from the farmers how they wished the NRDP had helped them to know more about NERICA.

4.3.1. Collaboration between SARI and MoFA during the NRDP

SARI collaborated with MoFA to select farmers in the study area and disseminated the innovation to them. The collaboration became necessary because agricultural innovation dissemination in Ghana is the core mandate of the AEAs of MoFA, not SARI staff. However, the multinational NRDP had four components [Technology Transfer, Production Support, Capacity Building, and Project Coordination (Modernghana.com/news), which required such collaboration between SARI and MoFA. The AEAs of MoFA were tasked with technology (innovation) transfer while SARI staff provided production support, capacity building, and project coordination. This collaboration added impetus to the NRDP and thus strengthened the existing research-extension-farmer linkage in the districts. SARI took the leading role to collaborate with the AEAs of MoFA and other stakeholders in the dissemination of NERICA due to the multilateral nature of the project (AfDB, 2012).

The farmers normally referred to the project staff as SARI staff, without any clear distinction between the extension agents whose primary responsibility is innovation dissemination and SARI staff who are mainly researchers. The experienced farmers explained, during focused group discussions, that unlike NERICA, there were other

agricultural innovations such as fertilizer, herbicide and pesticide applications that were introduced to them solely by the AEAs of MoFA prior to the NRDP. According to modernghana.com/news (2016), the NRDP was to be implemented by MoFA. However, SARI as a research institution of Ministry of Science and Technology played such an active role in the project because the innovation needed to be researched into to determine its suitability, adaptability and adoptability in the study area. Hence, the collaboration helped SARI and MOFA to complement each other's efforts in pursuit of a national goal in the two districts.

4.3.2. Years NERICA was introduced to Farmers and the Years they tried Its Cultivation

As presented in Table 4.6, NERICA was introduced to all the farmers during the NRDP and 89% of them tried it on their own during the same period. That shows that the farmers participated massively in the project. The project was undertaken progressively in phases and on yearly basis during which the innovation was introduced to the farmers from community to community, in the study area. About 1.1% of them said that although they participated in the project, they only tried it on their own after the project ended in 2010 (0.3% in 2011 and 0.8% in 2012). The years 2005 and 2006 were the modal years of NERICA introduction to 46.6% farmers and trial by 39.4% farmers respectively. Key informant interviews and FGDs revealed that the farmers were advised to try NERICA cultivation on a small plot of land (about ¼ acre) before deciding to adopt it. So those who tried growing the magic crop in 2011 and 2012 were not the same as those who adopted it (on large scale) during that period. They explained, during interviews, that some of them travelled out of their communities during the project period (due to schooling) and returned when the project ended. The farmers further explained during focused group

discussions that they cultivated the crop most during the NRDP but moved on to cultivate other crops when the project ended. It means they took keen interest in the crop as long as the project lasted. Results on Table 4.6 show that the introduction of NERICA to farmers in the study area stopped in 2010 and its trial also ended in 2012.

Table 4.6: Years NERICA was introduced and Years Farmers Tried it

Year	Year NERICA was Introduced		Year Farmers Tried NERICA	
	Frequency	*Percentage*	*Frequency*	*Percentage*
2005	176	46.6	20	5.3
2006	37	9.8	149	39.4
2007	37	9.8	42	11.1
2008	96	25.4	39	10.3
2009	16	4.2	104	27.5
2010	16	4.2	20	5.3
2011			1	0.3
2012			3	0.8
Total	**378**	**100**	**378**	**100**

Source: Field Survey, 2015

4.3.3. Innovation Dissemination Methods used to Introduce NERICA

The project used mainly used individual and group contacts to disseminate the innovation because they were more suitable to farmers without formal education than mass media. Unlike mass media, individual and group contacts are direct extension methods of teaching farmers for maximum impact. Radio was used during the awareness creation to stimulate farmers' interest about the project before their interactions with the project staff, which goes to confirm Rathod's (2016) position that indirect contacts of innovation communication do not work in isolation but

stimulate the need for direct contact in the target audience to seek further clarification from extension officers in the dissemination process.

Table 4.7: Innovation Dissemination Methods used to Introduce NERICA

Innovation Dissemination Method	Whether Method was used (%)	How Method helped Understand Innovation (%)			
	Yes	*Not at all*	*Somehow*	*Much*	*Very much*
Experimental plots	91.0	2.7	4.3	4.3	88.6
Demonstrations	87.8	2.8	2.6	11.1	83.5
Awareness creation/campaigns	93.7	3.7	0.0	43.7	52.6
Field days	94.7	5.3	14.0	8.7	72.0
Farm and home visits	93.7	2.6	0.8	18.5	78.0
Training sessions	74.3	11.6	13.8	13.0	61.6
Study/conducted tours (field trips)	77.2	12.4	8.7	28.3	50.5
Farmer field schools	92.6	2.6	10.6	1.9	84.9

Source: Field Survey, 2015

Rathod (2016) further classified the Extension Teaching Methods into spoken and written forms. The Extension Teaching Methods that involve oral interactions with farmers as shown on Table 4.7 are also classified as 'spoken forms' of innovation communication. The NRDP therefore employed the spoken forms (campaigns field days, training sessions, farm and home visits) but not the written forms (bulletins, leaflets, news articles, personal letters, circular letters, booklets and pamphlets) of communicating the innovation to the farmers. Unlike elitist societies, illiterate societies normally prefer oral tradition to documented literature as was the case here.

The spoken forms of innovation communication are less costly than those of the written or electronic forms (ICAR, 2006). The NRDP therefore employed more interactive and less expensive methods to disseminate NERICA in the study area. The methods and materials used in the NRDP depended on the nature of the target audience, purpose of the education, time and other resources available for the training.

Over 90% of the farmers indicated that all the dissemination methods were used with the majority indicating field days (94.7%), awareness creation/campaigns (93.7%), farm and home visits (93.7), farmer field schools (92.6%) and experimental plots (91%). The key informant interviews and focused group discussions confirmed that these were the only methods used to disseminate NERICA to farmers in the study area. These confirmations were in consonance with MoFA (2011) and www. Savannahagriculturalresearchinstitute.org (2013). It means the NRDP employed the most reliable and appropriate methods to introduce the innovation in the study area.

The farmers rated experimental plots (88.6%) as the most effective methods used to disseminate NERICA to them, followed by farmer field schools (84.9%) and demonstration farms (83.5%). They indicated that the least effective methods were study tours (12.4%) and training sessions. The two methods were not adjudged the worse because they were not good but because all the farmers did not get the opportunity to participate directly in them. The focus group discussions revealed that only the group leaders from the various communities were selected to participate in those two programmes. The key informants confirmed the above findings and stated that the reasons were to cut down cost of using those two methods and to ensure that group leaders would be able to pass on the knowledge gained from those two

methods to their group members. The group members expressed their reservations about that approach because they all wanted to get first hand information and knowledge from the project staff, with its perceived associated benefits.

Their responses about study tours and training sessions showed their inclination towards training, field trips and mass media methods of innovation communication. It implied that feedback from farmers is very essential in every innovation communication.

4.3.4 Farmers' views on how the NRDP could have helped them Further

The study further sought the views of the farmers on what they expected from the project to unable them know more about NERICA, which could help sustain the innovation in the districts. A number of suggestions were made and collated during the FGDs as presented on Table 4.8.

Table 4.8: Farmers' Views on How the NRDP could have helped them Further

Suggestions	Frequency	Percentage (%)
Field trips for rice farmers	61	26.1
Introduction of block farming	1	0.4
Linking rice farmers with NGOs	1	0.4
Training of rice farmers	102	43.6
Follow up to farmers rice farms	1	0.4
Provision of field equipment for rice farmers	10	4.3
Through radio and other mass media (campaigns)	54	23.1
Soil test result should be made known to farmers	1	0.4
Financial support for rice farmers	3	1.3

Source: Field Survey, 2015

The suggestions made showed their preferences and views on what they thought could help them know more about the innovation and sustain it. Training of rice farmers was on their priority list (43.6%) followed by field trips (26.1%), and radio and other mass media campaigns (23.1%).

These suggestions show that the idea of training only the group leaders and taking them on study tours to enable them train their group members and share their experiences with them was not a good idea to the farmers. According to the farmers, more mass media campaigns would help the innovation to diffuse faster than the direct contacts. The farmers' preference for mass media (indirect contacts) as a means of helping them know more about NERICA shows that they had become more sophiscated and aware of other extension methods of teaching farmers than the individual and group methods (direct contacts). This affirms Rathod's (2016) assertion that the indirect contacts do not work in isolation but in tandem with the direct contacts.

The least items on the farmers' scale of preference of ways of helping them know more about NERICA were; introduction of block farms (0.4%), follow up visits to farmers' farms (0.4%), linking them up with NGOs (0.4%), and the need for soil tests results to be made available to farmers (0.4%). These were not the felt needs of the farmers in the study area, since they could do without them but they perceived that those things could come along with some other material benefits or financial gains.

4.3.5. Extension Teaching Methods available to Farmers after the NRDP

During the field survey, the rice farmers sampled were asked to indicate whether the extension teaching methods that were used to introduce the NERICA to them were still being practiced in the communities. The purpose of the question was to assess whether the methods were still needed for the sustainability of the project. Table 4.9 reports the results.

More than 80% of the rice farmers interviewed during the field survey indicated that the extension teaching methods were not being practiced in the communities as at the time of this study, because the project had ended. Adherence to those methods was therefore irrelevant to the sustainability of the project. However, Asuming-Brempong *et al*, (2011) and Glenna *et al*, (2012) suggested that much effort and resources should be invested in promotional activities to facilitate both the exposure and continuous adoption of the NERICAs among farmers in Ghana.

Table 4.9: Extension Teaching Methods available to Farmers after the NRDP

Extension Teaching Methods	Still Available to Farmers		How Farmers are Still Exposed to the Methods (%)			
	Yes	*(%)*	*Not at all*	*Somehow*	*Much*	*Very much*
Experimental plots	84	22.2	43.9	43.7	5.0	7.4
Demonstrations	107	28.3	43.9	42.9	2.4	10.8
Awareness creation/campaigns	107	28.3	43.9	40.2	10.3	5.6
Field days	107	28.3	43.9	48.7	7.4	0.0
Supervisory (farm and home) visits	106	28.0	42.1	41.3	8.7	4.9
Training sessions	106	28.0	41.8	50.5	0.8	6.8
Study/conducted tours (field trips)	109	28.8	43.0	43.0	10.9	3.1
Farmer field schools	116	30.7	41.8	47.8	10.3	0.0

Source: Field Survey, 2015

The farmers' response in this section of the study revealed that the NRDP objective of technology transfer to farmers was achieved because the farmers claimed they knew the methods of NERICA cultivation. What they needed was motivation to ensure total adoption, not availability of the dissemination methods. Those ''promotional activities'' had ''motivational packages'' such as free input, extension services, and ready market for farmers, which supports Glenna *et al* (2012) assertion that the objectives of the NRDP would be a mirage if efforts are not made to ensure "total adoption" and the existing adoption gap closed. In essence, both Asuming-Brempong *et al* (2011) and Glenna *et al* (2012) shared the same view of project sustainability by sympathizing with the farmers who needed more motivational packages. This study supports their view in that, the NRDP was very comprehensive except that its motivational package for the farmers was short lived. Key informant interviews and FGDs revealed that extension delivery services (farm and home visits) are still available to farmers at a fee. The farmers are currently unable to make good use of this extension service delivery due to high cost involved. The AEAs are also unable to adequately meet demands of the farmers because they are under resourced and poorly motivated. This confirms Donkoh and Awuni (2011) finding that the problem of poor extension delivery system in Ghana and many other developing countries is improper motivation of the inadequate extension staff. This shows that agricultural extension service delivery in Ghana cannot be privatized, since many farmers cannot afford to hire them.

4.3.6 Conclusions on the Methods Used to Introduce NERICA to the Farmers

Appropriate extension teaching methods were used to introduce NERICA to the farmers in the study area but the farmers did not adhere to those methods when the

project ended. That was because the farmers did not consider such methods necessary anymore since there were no more motivational packages associated with those methods of cultivating NERICA.

4. 4. Adoption of NERICA

The second objective of this research was to examine the adoption of NERICA in the study area. This sub-section looked at the NERICA varieties cultivated in the study area and their farm sizes, other rice varieties cultivated in the study area, yields and prices of rice varieties cultivated in the study area, and reasons for cultivating other rice varieties. It also examined the production of NERICA seeds and grains during the NRDP, the adoption of NERICA from 2011 to 2014, farmers' reasons for adopting NERICA, the NERICA variety farmers liked most in the study area and reasons respondents gave for their choice of NERICA variety.

4.4.1. Varieties of NERICA Cultivated and their Farm Sizes

Table 4.10 shows that the farmers cultivated NERICA 1 and NERICA 2 and on small scales (acres) in the study area. This is primarily because the innovation was introduced to peasant farmers who did not have the means to cultivate large hectares. This is in tandem with the AfDB (2012) that the primary beneficiaries of the multinational NRDP, across West Africa, were mostly subsistence farmers who sold marginal surpluses to meet cash expenses, such as for education, health care, and other basic household needs. It further confirms Martey *et al* (2013) assertion that the beneficiaries of the multinational NRDP in Ghana were small holder farmers.

Table 4.10: Farm Size and Number of Farmers Cultivating NERICA 1 and 2

Year	Number of Farmers who Cultivated and Mean Farm Size						Total
	NERICA 1			*NERICA 2*			
	Number of Farmers who Cultivated	*Farm Size (Acres)*		*Number of Farmers who Cultivated*	*Farm Size (Acres)*		
		Mean	*Maximum*		*Mean*	*Maximum*	
2006	156 (41.3)	1.1	2	32 (8.5)	1.3	2	188
2007	155 (41.0)	1.2	2	32 (8.5)	1.3	2	155
2008	92 (24.3)	1.3	2	17 (4.5)	1.0	1	109
2009	83 (22.0)	1.5	4	52 (13.8)	1.3	3	135
2010	84 (22.2)	1.3	4	61 (16.1)	1.3	3	145
2011	94 (24.9)	1.3	4	58 (15.3)	1.6	6	152
2012	76 (20.1)	1.2	4	31 (8.2)	2.2	6	107
2013	79 (20.9)	1.2	4	23 (6.1)	1.9	6	102
2014	75 (19.8)	1.23	4	10 (2.6)	1.00	1	85

Note: Values in bracket are percentages; minimum farm size for the two varieties for all the years is 0.5 acres. Source: Field Survey, 2015

The farmers had high expectations from the project but some of their expectations such as ready market for their produce were not met so they withdrew from the project with time. On the other hand, farmers who continued with the project had high hopes of getting ready market for their produce so they increased their farm sizes so as to harness the fortunes of the project. However, when the project finally ended, their hopes were dashed and they abandoned the innovation.

The farmers also explained during interviews and focus group discussions that they were advised to start the project on a small scale until they were used to it and had the needed resources to cultivate it on large scale. According to them, they held on to the advice because it was better for them to cultivate smaller farms and manage them well for higher yields than to have larger farms that they could not manage well and end up with lower yields. So when the smaller farms yielded higher, they had

enough income to buy more input for cultivating bigger farm sizes that they could manage well.

4.4.2. Other Rice Varieties Cultivated in the Study Area

Apart from NERICA, the respondents cultivated other varieties of rice. Almost all the farmers (98.6%) indicated that they cultivated other varieties of rice in addition to NERICA, because NERICA was not their main crop. Only 1.4% of them said they cultivated only NERICA on their rice fields. According to the experienced farmers, it is not advisable to continue cultivating the same type of rice on the field after four successive years; hence they change the cultivated varieties from time to time.

The varieties they cultivated includes: *abelkukuo, afefa, assembly man, bazoligu, bunbase, digan, jasmine, faro, GR 18, GR 19, jakuku, jasmine, kpokpula, kuldayaro, mande, NR 12, Thailand, torks, BR 19, AGRA, kanbonpaya, VR 18, moses, Nigerian, salmasa, and ayofula.* The most cultivated ones are afefa, GR 18, kpokpula, faro, Thailand, jasmine, bunbase, digan, and abelkukuo. The minimum farm size for these rice varieties is 0.5 acres while the maximum is 7 acres and a mean of 3.8 acres.

The mean farm sizes are similar to those of NERICA 1 and 2. That is because they used the same rice field for NERICA and all the other varieties, by alternating the crops year by year or dividing the fields for NERICA and the other rice varieties in some cases. They cultivated NERICA because it was convenient for them to grow it on their existing farm lands without expanding their farm sizes.

4.4.3. Yields and Prices of NERICA Varieties Cultivated in the Study Area

Table 4.11 shows the yields and prices of rice varieties farmers cultivated in the study area. It shows that the yields were very low. That is in tandem with Larsson *et al* (2010), that in places where NERICA has been introduced, overwhelming evidence from the field of substantial yield benefits were slim. This contradicts the AfDB (2014) estimation of NERICA yields at 1,500 kg/hectare without fertilisers and 2,500 kg/hectare using fertilisers compared to traditional rice yields of 800 kg/hectare. It therefore implies that the NERICA yields in the study area were similar to the traditional rice yields found by the AfDB. Meanwhile, farmers tend to adopt higher yielding crop varieties than the lower yielding ones.

Although NERICA did not yield higher in the study area, it was early maturing and tolerant to water stress; it had short straw, good taste and flavour. This goes to confirm Kijima *et al* (2005), who found in Uganda that though NERICA is said to be drought resistant, its production is subject to large variations, depending on rainfall. The AfDB (2014) also has it that about 80% of the targeted project beneficiaries across Africa were women and poor people who could not maximize the potentials of the magic crop, so, higher yields and higher market prices do not seem to be the ultimate aims of the project. The farmers in the study area could not record the average yield of 2.5 t/ha as reported by the AfDB (2012) for Ghana, due to poor soil and environmental conditions in the study area.

Table 4.11: NERICA Yields in the Study Area (2006 – 2014)

Year	Yield/Acre (bags, 50kg/bag) of Paddy Rice					
	NERICA 1			NERICA 2		
	Minimum	*Maximum*	*Mean*	*Minimum*	*Maximum*	*Mean*
2006	1	22	9.8	6	30	18.6
2007	2	24	9.3	2	40	16.5
2008	5	20	10.0	7	50	21.3
2009	5	20	13.9	7	30	14.5
2010	1	20	11.9	1	30	12.0
2011	5	19	11.4	11	30	16.2
2012	6	21	11.2	21	21	21.0
2013	1	19	11.0	20	100	65.7
2014	1	25	7.9	10	10	10.0

Source: Field Survey, 2015

The yields per acre of paddy rice were higher for NERICA 2 than for NERICA 1. The highest mean yield per acre of NERICA 2 was 65.7bags while that of NERICA 1 was 13.9 bags, meaning NERICA 2 was more productive than NERICA 1. The least mean yields of NERICA 1 (9.3bags/acre) and NERICA 2 (10.0bags/acre) were both recorded in 2014. The least mean yield of NERICA 2 in 2014 was the same as the sixth highest yield of NERICA 1 recorded in 2008. The mean yields for NERICA 1 increased from 2006 to 2009 and declined from 2009 to 2014. The mean yield of NERICA 2 declined from 18.6 are in 2006 to 16.5 bags /50kg/acre in 2007 but rose to 21.3 bags /50kg/acre in 2008. The yield then took a downward turn till 2013 when it rose to 65.7 bags/kg/acre. That of NERICA 1 equally took a downward turn from 2010 and did not rise again till it recorded 7.9 bags/kg/acre in 2014, which shows a diminishing return in NERICA 1 yields per acre. Since NERICA 2 yielded higher than NERICA 1 in the study area, the farmers were likely to adopt NERICA 2 more than NERICA 1.

The yields and prices per bag of local rice in the study area were much lower than those of NERICA, as can be gleaned from Tables 4.12 and 4.13. The average farm gate price for NERICA in study area was also far below the international standard of USD 250/ton on average, reported for Ghana, due to low output levels among the farmers (AfDB, 2012). Local farm gate prizes were therefore fixed annually per bag (50kg) of NERICA instead of per tonne of NERICA for the farmers.

Table 4.12: Price of NERICA in the Study Area (2006 – 2014)

Year	Price (per bag in GH₵) of Paddy Rice					
	NERICA 1			NERICA 2		
	Minimum	*Maximum*	*Mean*	*Minimum*	*Maximum*	*Mean*
2006	10	50	39.1	20	30	19.7
2007	20	60	42.1	35	50	41.6
2008	30	80	50.7	40	50	46.3
2009	40	80	56.5	50	60	53.9
2010	60	80	66.8	60	70	63.9
2011	70	90	76.4	70	90	78.4
2012	80	100	90.3	90	90	90.0
2013	70	120	88.5	100	100	100.0
2014	70	120	105.1	80	80	80.0

Source: Field Survey, 2015

The prizes were unstable, as they varied from year to year in the localities. The prices per bag of NERICA from 2006 to 2009 were very low because SARI provided all the input to the farmers for the cultivation. The farmers explained during FGDs that they virtually produced the crop for SARI, and not to sell for profit. There was no secondary data at SARI to confirm the farmers' assertion. Key informants at SARI confirmed that the selected farmers were simply given incentives to produce

NERICA seeds for distribution to other farmers during the NRDP. So what the farmers claimed as the price for NERICA was simply a token they received from the project for their efforts. Those who produced grains sold their produce to middle men and market women most of whom were not formally educated and therefore did not keep any official records. The prices as quoted on Tables 4.12 and 4.13 are therefore arbitrary figures from the farmers and can therefore not be compared with international prices.

The prices of NERICA 1 and NERICA 2 increased with time due to inflation in the Ghanaian currency. The highest mean price for NERICA 1 (GH₵105.00/bag of paddy rice) was recorded in 2014 while that of NERICA 2 (GH₵100.00) was in 2013. The prices of both NERICAS were similar. MoFA (2011) confirmed that NERICA prices were also similar to other rice varieties in the study area.

Table 4.13A: Yields and Price of other Rice Varieties Cultivated in the Study Area (2006 – 2014)

Year	Yield (in 50kg bags) and Price (in GH₵)					
	Yields (bags) of Paddy Rice			Price (per bag) of Paddy Rice		
	Minimum	*Maximum*	*Mean*	*Minimum*	*Maximum*	*Mean*
2006	6	48.5	15.4	20	70	34.0
2007	6	50.0	14.2	25	85	42.6
2008	4	70.0	16.8	30	90	50.0
2009	1	67.5	16.2	40	95	58.2
2010	3	67.5	19.1	45	105	63.3
2011	3	56.0	18.7	50	100	64.4
2012	4	65.0	18.7	40	105	69.7
2013	3	60.0	18.1	50	110	86.2
2014	3	50.5	15.4	68	120	104.8

Source: Field Survey, 2015

The survey report shows that the prices of NERICA and the other rice varieties in the study area increased with increase in years, possibly due to inflation. Although the yields and prices of NERICA and other rice varieties were not higher in the study area, there were reasons and other advantages for which the farmers alternated NERICA with other rice varieties.

The average market prices of paddy rice obtained from the Tolon and Kumbungu District Directorates of MoFA were not markedly different from the mean prices of NERICA and other rice varieties obtained from the survey. That was in tandem with MoFA (2011) assertion that NERICA prices were also similar to other rice varieties in the study area.

Table 4.14: Market Price of Paddy Rice in the Study Area from 2006 to 2014

Year	Price (per 50Kg bag) of Paddy Rice		
	Least	**Highest**	**Average**
2006	44.93	52.83	47.37
2007	36.20	59.55	44.72
2008	40.20	119.22	48.97
2009	80.33	84.32	78.92
2010	63.22	86.10	74.13
2011	80.60	115.88	97.69
2012	112.80	152.58	137.63
2013	146.58	175.04	156.34
2014	147.63	175.04	156.34

Source: MoFA, Tolon and Kumbungu District Directorates, 2017

The only conspicuous differences between the market price of paddy rice and survey prices of NERICA and other rice varieties could be seen in 2012, 2013 and 2014 respectively. The market price was about GH₵50.0 higher in those years than that of the survey price, which could be due to inflation. The slight differences between the market price of paddy rice and price of rice obtained during the survey showed that the farmers sold their rice at farm gate price rather than the market price. That was because key informant interviews and focus group discussions revealed that after the project period in 2010, there were middle men who bought the paddy rice (NERICA) directly from the farmers and transported them to market centres for sale and processing. The cost of transportation accounted for the differences between the farm gate and market prices of both NERICA and other paddy rice in the study area. The market price of paddy rice in the study area was therefore not NERICA specific, as shown on Table 4.14.

4.4.4. Reasons given by Respondents for Cultivating Other Rice Varieties

The other varieties were cultivated in the study area because:

1. The farmers were cultivating them before the introduction of NERICA.
2. They required low inputs compared with NERICA.
3. Some varieties were also introduced by SARI, MoFA and NGOs after NERICA was introduced.
4. These varieties grow taller than NERICA hence they suppress weed growth.
5. They are also drought resistant like NERICA.
6. They had better or good market than NERICA.

4.4.5. NERICA Seed and Grain Production during the NRDP

The farmers were also asked to indicate whether they produced NERICA seeds or grains during the project period. Their responses show that they produced both seeds and grains during the NRDP. They primarily produced seeds at the beginning of the dissemination period and produced grains in course of the project and thereafter. Large quantities of seeds were produced during the NRDP, stored and distributed to farmers for mass production of grain (MoFA, 2010). However, not much grain was produced after the NRDP as expected because according to the farmers, there was no ready market for the grains after the NRDP. The project exit strategy was such that SARI would not buy NERICA from the farmers or link them up to potential buyers. Hence, not many farmers produced NERICA after the project since the famers were expected to look for market for their own produce after the project (MoFA, 2011).

Their responses during interviews and FGDs show that the farmers were mainly interested in the personal gains from the project but not for the overall aim of the NRDP, which was to affirm the government's commitment to revamp the local rice sub sector in Ghana (MoFA, 2010). Lack of personal gains such as free farm input, access to free extension services, as well as access to free tractor and harvester services from the project resulted in massive decline in grain cultivation after 2010.

All farmers who produced seeds at the onset of the NRDP also produced grains in course of the project. It was therefore not possible to separate the grain growers from the seed growers during the data collection and analysis. So this study simply referred to all respondents selected from the sample frame as NERICA farmers, in order to avoid duplication of project participants and repetition of information.

4.4.6. Adoption Rates of NERICA in the Study Area from 2011 to 2014

Adoption of NERICA in the study area occurred only in 2011 when the project support was still available to the farmers. Disadoption of NERICA occurred in 2012, 2013 and 2014 respectively, as shown on Table 4.15. Disadoption is a wilful refusal to adopt an innovation after one has earlier adopted it. Rogers (2003) refers to this phenomenon (disadoption of an innovation) as active rejection or discontinuous adoption of an innovation.

Table 4.15: Adoption of NERICA in the Study Area from 2011 to 2014

Year	Adoption		Non-Adoption		Remarks
	Frequency	Percentage	Frequency	Percentage	
2011	333	88.1%	45	11.9	Adoption
2012	4	1.1%	374	98.9	Disadoption
2013	4	1.1%	374	98.9	Disadoption
2014	5	1.3%	373	98.7	Disadoption

Source: Field Survey, 2015

About 88.1% of the farmers said they cultivated NERICA in 2011, meaning most of them adopted the innovation that year. The adoption rate for 2011, in the study area, was higher than what was estimated for West Africa in general and the study area in particular. In 2011, the actual adoption rate across West Africa (Benin, Gambia, Ghana, Guinea, Nigeria, Mali and Sierra Leone) was estimated to be about 43%, while the potential adoption rate was estimated at about 63%, leaving an adoption gap of 20% (AfDB, 2014). This is due to the fact that adoption rates of NERICA are location specific.

The disadoption of NERICA in the study area occurred in 2012, 2013 and 2014 due to lack of ready market for the commodity, insufficient funds to farm, seed

contamination and poor soil fertility. That meant that the farmers almost abandoned the innovation a year after the project ended, which shows a *discontinuous adoption*. It however started to pick up in 2014, probably because the farmers normally changed from growing one variety of rice to another on the same piece of land after every four years. So the adoption rate of NERICA in the study area as at the end of 2014 was 1.3%. If their reason of alternating the rice varieties on the same pieces of land after every four years is anything to go by, then the abysmal increase to 1.3% in 2014 was nothing to write home about. It can therefore not be called a 'magic crop' to farmers in the study area. There is not much difference between the adoption rates of NERICA in 2010 and 2014. These findings are in tandem with Diagne *et al*, (2010) that though NERICA is a successful innovation, its adoption rates across Africa are low.

It could therefore be concluded that the fact that an innovation is regarded as successful does not automatically make its adoption to be successful or higher, because NERICA adoption was discontinued in the study area. Adoption also means acceptance and continuous use of an innovation. So if the farmers' reason of alternating the rice fields stand (all things being equal), and they resort to NERICA cultivation as expected of them, then NERICA adoption rates are likely to increase from 2014 to 2017 and fall again in 2018. When that happens, then the cumulative NERICA adoption in the study area would assume the normal sigmoid (s-shaped) curve as predicted by Rogers (2003). If the pattern repeats itself in another eight years, then continuously, the adoption of the innovation in the study area would be in a serpentine order. The serpentine order would then result in a normal bell-shaped adoption curve, which implies that it would take the 'magic crop' about sixteen years

to have a normal adoption curve, which is likely to be a façade. This is due to farmers' poor attitudes to governmental projects and the availability of other rice varieties in the study area to be cultivated in turns. Most governmental projects in Ghana suffer from lack of sustainability and are easily abandoned either with change in government, poor supervision or inadequate funds for maintenance (Lamptey, 2006).

Thus, the adoption of NERICA from 2011 to 2014 in the study area did not result in a normal bell-shaped curve, as Rogers (2003) postulated, possibly due to the fact that the study period (4 years) for NERICA adoption was too short. However, Rogers (2003) did not give a specific time frame within which an innovation should generate a normal adoption curve. There is therefore a research gap in Rogers' (2003) adoption theory.

4.4.7. Farmers' Reasons for not Adopting NERICA

The rice farmers interviewed also gave reasons why they attempted to adopt NERICA from 2011 to 2014. These include the following: for food (36.1%), for income (60.1%), for food and income (27.9%), suitable for my field (83.3%), I understood the methods involved (32.7%), land was available (39.3%), and seed was available (71.0%). These responses showed that the farmers cultivated NERICA because they had enough seeds, which were suitable to their rice fields. Their reasons for cultivating NERICA were similar to those they gave for participating in the NRDP, which seemed more personal than national or multinational reasons. The project staff confirmed that these are characteristics of peasant farmers.

The farmers stopped cultivating NERICA because according to them, "NERICA's time had passed" and there were no more incentives for its adoption. They were therefore looking forward to new projects with better motivational packages to help better their lots. It shows that the farmers participated in the project due to the immediate benefits they could derive from it but not for its long term goals of revamping the local rice sub sector, increasing gross domestic product, reducing rice import into Ghana, creating employment and improving food security (MoFA, 2010). Since adoption of NERICA did not occur in the study area, the aims of the NRDP would be a facade, unless there is a massive adoption of NERICA in other project areas in Ghana and Africa. This in tandem with Glenna *et al* (2012) position that the objectives of the NRDP would be a mirage if efforts are not made to ensure "total adoption" and the existing adoption gap closed.

4.4.8. The NERICA Variety Farmers Liked Most in the Study Area

Figure 4.1 shows that NERICA 1 and NERICA 2 were introduced to the farmers in the study area: 52.7% of the farmers were introduced to NERICA 1, 6.7% were introduced to NERICA 2 while 40.2% of the farmers said both NERICA 1 and 2 were introduced to them. Hence, more farmers were introduced to NERICA 1 and NERICA2. This confirms MoFA (2010) that two of the NERICA lines (N1 and N2) were released during the NRDP in Ghana. Both varieties became available in the communities after the trial period, which gave the famers opportunity to indicate which one they preferred. NERICA 1 automatically had an upper hand over NERICA 2 because the farmers were more acquainted with NERICA 1 than NERICA 2, hence 69.3% of the farmers preferred NERICA 1 to NERICA 2. This suggests that NERICA 1 was the most preferred variety among the farmers.

The reverse would have been the case if more farmers were exposed to NERICA 2 than NERICA 1. On the other hand, the farmers preferred choice of the magic crop varieties would have been more authentic if they had equal (50%) exposure to each variety. The FGDs also revealed that some of the farmers could not really tell the differences between the two varieties. Those who really knew the differences between the two varieties gave various reasons for their preference of NERICA 1 over NERICA 2. That explains Pingali *et al* (2001) position that farmers are capable of commenting on the particular technologies introduced to them and suggesting changes that would make such technologies and innovations more appropriate to meet their needs.

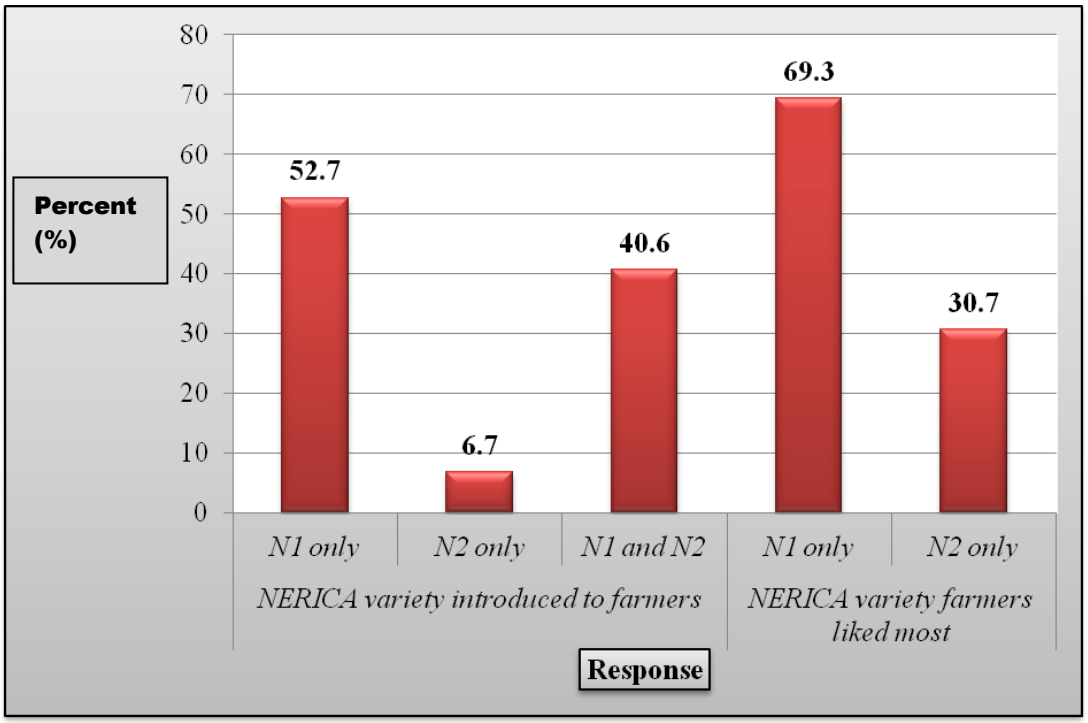

Figure 4.1: NERICA Varieties Introduced to Farmers and the one they Liked Most
Source: Field Survey, 2015

4.4.9. Reasons Respondents gave for their Choice of NERICA Variety

The farmers were given a set of attributes/characteristics of the crops to choose from, during the field survey, to come out with the reasons why they liked the NERICA

varieties chosen. The results are reported in Table 4.16. All the farmers (100%) affirmed that both NERICA 1 and NERICA 2 were early maturing, had good grain quality, good taste, good cookability and good palatability. Most of them (97.4%) also said that both varieties had nice aroma. None of the farmers stated any other good qualities of their choice of NERICA besides those tabulated below.

Table 4.16: Attributes of NERICA 1 and NERICA 2 Varieties Farmers Liked

Attributes of NERICA 1 and 2	Frequency	Percentage (%)
Drought resistant	290	76.7
Early maturity	378	100.0
Good grain quality	378	100.0
Good taste	378	100.0
Low grain yield	245	64.8
Short straw	286	75.7
Low input requirements	153	40.5
High grain yield	264	69.8
It is a low land/upland rice	310	82.0
Increased productivity	332	87.8
Reduced grain loss due to processing	145	38.4
Good cookability	378	100.0
Increased palatability	378	100.0
Nice aroma	368	97.4
Ready market/good market price	291	77.0

Source: Field Survey, 2015

They however indicated that what made NERICA 1 the most preferred choice was the fact that it grows taller to smother weeds than NERICA 2. The farmers appear to have an inclination towards rice varieties that grow taller to suppress weeds than the shorter ones, which was one of the reasons why they grew other rice varieties as discussed earlier in this chapter (4.4.4).

4.4.10. Conclusions on the Adoption of NERICA in the Study Area

Adoption of NERICA in the study area only occurred in 2011 when project support was still available to the farmers. Disadoption of NERICA occurred in 2012, 2013 and 2014 respectively, due to lack of incentives for its adoption. The specific adoption rates of NERICA from 2011 to 2014 were 88.1; 1.1, 1.1 and 1.3 for 2011, 2012 13 and 2014 respectively. It means the innovation was not adopted by the farmers in the study area.

4.5. Factors Affecting the Adoption of NERICA among Rice Farmers

The third objective of the study was to determine the factors affecting adoption of the innovation among the rice farmers in the two districts. This sub-section of the study presents the product characteristics of NERICA that affected its adoption and logistic regression of the socio-economic characteristics of rice farmers that affected adoption of NERICA. These two key parameters are necessary for this study because for any innovation to be adopted, the perceived characteristics of the innovation as well as the personal and socio-economic characteristics of its potential adopters should be considered (Umunna, 2010; Lamptey, 2006; Rogers, 2003).

4.5.1. Perceived Characteristics of the Project that Ensured NERICA Adoption

Rogers (2003) propounded that innovations that are less complex, more compatible with the social system, observable, and have relative advantage, triability with the possibility of re-invention are more likely to be adopted more than those that are not or do not have those desirable traits. An analysis of how the innovation was packaged and introduced to the farmers in the study area showed that NERICA passed litmus test for Rogers (2003) innovation adoption as shown on Table 4.17.

Table 4.17: Perceived Characteristics of the Project that Ensured NERICA Adoption

Narration	Response	
	Frequency	*Percentage*
NERICA rice is better than others	259	68.5
Can use same tools, equipment, chemicals for other rice to cultivate NERICA	374	98.9
Grew NERICA on small scale/plot before adoption	366	96.7
Saw the performance of NERICA during demonstrations	378	100.0
Can change the physical structure of NERICA plant	60	16.0
Can change methods of growing NERICA	69	18.3

Source: Field Survey, 2015

All the farmers indicated that they saw the demonstrations of how NERICA was cultivated before they decided to try it on their own. About 92.7% the farmers further indicated during interviews that they observed the demonstration farms of project staff, 2.4% of them also said they observed the demonstrations farms of other farmers in the community while 4.9% then said they observed the demonstration farms of both the project staff and those of other farmers. It means the innovation was observable because all the farmers had the opportunity to observe how NERICA is cultivated before deciding to try it on their own and later adopt it. Since 75.0% of the farmers described the methods of growing NERICA as very easy it means, it is not difficult to cultivate NERICA.

They further pointed out that they could change the look (morphology) of NERICA through the following ways.

- Supply of more water to rice plant on the field
- Application of more fertilizer
- Removal of bad rice from the farm

- Regular weeding

Agronomically, what the farmers meant by changing the physical outlook of NERICA was in actual fact giving the plant the favourable environmental conditions to grow to its maximum potential. They agreed to the fact that they could not change the genetic make-up of the plant because that was the work of plant breeders, not farmers. The farmers said during FGDs that they could change the physical structure of the plant but not the nature of the plant. They further iterated that they could modify the methods of cultivating NERICA to suit their local conditions and ways of farming and still derive maximum yield from the plant. That means the innovation was adaptable in accordance with Rogers (2003) theory.

Thus, the farmers' description of the innovation showed that NERICA had 68.5% relative advantage over other rice varieties in the study area, 100.0% observability, 96.7% triability, 98.9% compatibility, 16.8% complexity and 18.3% adaptability or possibility of re-invention. Though these perceived characteristics of NERICA were necessary to ensure its adoption, the adoption would also depend on the personal and socio-economic characteristics of the farmers.

4.5.2. Socio-Economic Factors of Farmers Affecting Adoption of NERICA

The logistic regression analysis was used to analyse these factors and the results presented in Table 4.17. The probability of 0.00 indicates that Wald Chi-square (F-statistic) is significant and this means that the independent variables jointly influence farmers' decision to adopt NERICA. The Pseudo R-squared of 0.208 indicates that about 20.8% of the variation in the probability of adoption is explained by the factors

used for the study. The remaining 79.2% of the variations are explained by other factors.

Table 4.18: Logistic Regression of Factors Affecting NERICA Adoption

Variable	Coefficient	Standard Error
Age	-0.165	0.314
Marital status	1.731	1.559
Educational level	0.464***	0.106
Years of experience in rice cultivation	0.326	0.213
Household size	-0.347*	0.213
Primary occupation	-1.750*	1.048
Think NERICA is better than others	1.879***	0.508
Number of Observations	368	
Probability	0.000	
Pseudo R^2	0.208	

Note: ***, ** and * implies significance level at 1%, 5% and 10% respectively
Source: Field Survey, 2015

Farmers' educational level, household size, primary occupation and whether they thought NERICA is better than other rice varieties in the study area significantly affected their adoption of NERICA. Out of these 4 statistically significant variables, 2 had a positive effect on NERICA rice technology adoption.

These indicate that as farmers' educational level increases their ability to adopt NERICA also increases. In other words, farmers with a higher level of education have higher probability of adopting the technology than those with lower educational level. This may be due to the fact that educated farmers are more business oriented than their uneducated counterparts. Those who are more business oriented with farming will always want new and improved varieties of crops such as NERICA. In addition, farmers with more years of education are expected to have better

information and knowledge about improved technologies than those who are not educated. As a result, the positive sign of education was expected since educated farmers are more prone to adoption because they have tendency to co-operate favourably with other farmers (Martey *et al*, 2013; Enete and Igbokwe, 2009; Ofori, 1973; Southworth and Johnston, 1967; and Schultz 1945).

As expected, farmers in the study area who think NERICA is better the other rice varieties have a higher probability of adopting the technology than those who think otherwise.

Household size was significant at 10% but had a negative effect on NERICA technology adoption. This implies that as household size increases, the probability of technology adoption reduces. In other words, households with fewer members adopted the technology better than those with more household members, which seem to contradict the expectations of this study. The nature of the NERICA technology required more labour and was favoured by large household size. On the other hand, the technology required higher level of financial commitment such as the acquisition of more and new input and that did not favour households with large members since funds to be used for farming was reduced to settle the high household expenditure. Hence, farmers with large household sizes who lacked funds to farm did not adopt NERICA better than those who had smaller household size but had funds and other resources to farm. This confirms Yoko (2008) finding that adoption of NERICA in Africa is influenced by risks and opportunity cost.

Primary occupation was significant at 10% but negatively influences NERICA technology adoption. The negatively sign coefficient favours respondents whose primary economic occupation was crop production. Such farmers have dedicated

much of their time to crop production and obtained most of their livelihood from crop farming. As a result, they may be more interested in new and high yielding crop varieties like NERICA than their counterparts who have taken crop production as a secondary occupation and may not give it more attention since it serves as a minor source of livelihood for them. This result was expected and plausible.

Table 4.17 further suggests that farmer's age, marital status and years of experience in rice cultivation were insignificant and had no effect on NERICA technology adoption. This means that older and experienced farmers did not adopt NERICA technology more than the younger and inexperienced farmers. This result was as expected because the study postulated that farmers who have more experience may rely on their accumulated experience and may be unwilling to adopt new technologies. It confirms Rogers' (2003) position that aged or older farmers tend to be laggards who are skeptical when it comes to adopting new technologies. This finding is true because most of the NERICA farmers were young and productive (below 60 years) but inexperienced. This finding contradicts Kijima *et al* (2005) finding that farmers' experience in growing rice has a positive and significant effect on the NERICA yield (adoption) in Uganda. Although majority of the farmers were married, marriage was not a necessity for NERICA adoption because the farmers who were married did not adopt NERICA more than those who were not married.

4.5.3. Conclusions on Factors Affecting Adoption of NERICA

Factors that significantly affected the adoption of NERICA in the study area included farmers' educational level, household size, primary occupation and whether

they thought NERICA was better than other rice varieties in the study area. Farmers' educational level positively affected adoption of NERICA at 1% significant level, meaning as their level of education increases, their ability to adopt NERICA also increases. Household size was significant at 10% but had a negative effect on NERICA technology adoption, which implies that as household size increases, the probability of technology adoption reduces. Primary occupation was significant at 10% but negatively influences NERICA technology adoption. As expected, farmers in the study area who thought NERICA was better the other rice varieties had a higher probability of adopting the technology than those who thought otherwise, hence their perception of the innovation positively influenced its adoption at the 1% significant level.

4.6. Challenges and Prospects of NERICA Adoption in the Districts

The various challenges and prospects of NERICA adoption in the districts are discussed in this sub-section, as the fourth objective of the study.

4.6.1. Challenges of NERICA Adoption in the Districts

The most serious constraint farmers faced in the adoption of NERICA in the study area was insufficient finance to farm (98.1%), as shown in Table 4.18. It confirms Sunding and Zilberman's (2000) position that one of the key constraints to adoption and diffusion of innovations is credit. That is because, if the price of credit is higher for smaller farms, that extra hurdle will reduce the minimal farm size that is required for new technology adoption and will slow adoption by smaller sized farms. Martey *et al* (2013) also collaborates this notion by stating that access to credit serves as an

incentive for farmers to increase their production and overcome the financial constraints in participating in development projects which also has a direct impact on their livelihoods.

Table 4.18: Challenges Farmers Faced in NERICA Adoption

Challenges	Extent to which Farmers Consider it as a Constraint (%)		
	Not a constraint	*Mild constraint*	*Serious constraint*
Unstable market price (either high or low)	42.9	51.6	5.6
Lack of ready market for NERICA	28.8	44.7	26.5
Insufficient finance to farm	0.0	1.9	98.1
Inadequate access to extension service	42.1	51.6	6.3
High cost of innovation	24.6	46.8	28.6
Lack of production skills	66.7	31.2	2.1
Inadequate supply of tractor and harvester services	2.1	10.1	87.8
No subsidy on input prices	59.0	30.7	10.3
Shortage of land for farming	56.3	9.5	34.1
Poor soil fertility	41.0	12.2	46.8
High disease attack (not resistance to diseases)	54.5	42.9	2.6
Seed contamination	9.3	39.2	51.6
Lack of incentive for adoption of innovation	18.3	43.4	38.4
Limited access to inputs on credit	24.9	8.5	66.7
Non-membership of cooperatives	76.7	11.6	11.6
Bureaucracy/institutional arrangements	68.5	28.8	2.6
Cultural/religious/political interferences	73.3	26.7	0.0
Variety not known to farmers	74.3	25.7	0.0
Labour intensive	91.5	3.0	5.4

Source: Field Survey, 2015

This finding further confirms AfDB (2014) that the primary beneficiaries of the multinational NRDP, across West Africa, are peasant upland rice producers who sold marginal products to meet personal expenses like wards' school fees, hospital and utility bills, but not for commercial purposes.

Other serious constrains of NERICA production in the study area were inadequate supply of tractor and harvester services (87.8%), limited access to inputs on credit (66.7%), seed contamination (51.6%), lack of incentive for adoption of innovation (38.4%), high cost of innovation (28.6%) and lack of ready market (26.5%). These constrains further confirm the fact that the farmers were peasant farmers who do not have what it takes to adopt and produce NERICA commercially (AfDB, 2014; Martey *et al*, 2013; Sunding and Zilberman, 2000). Even though availability of land was not a constraint in the study area, there was shortage of fertile land for NERICA farming. Besides, seed contamination was considered as a serious challenge to NERICA cultivation in the study area. According to the farmers, there were no pure NERICA seeds in the communities any more. They indicated during interviews and FGDs that pure NERICA seeds could only be purchased from SARI and other certified seed sellers in Tamale. That means the farmers could not maintain the genetic purity of the magic crop introduced to them. That should be expected due to the problem of hybridization that leads to recessive traits in a crop showing up in the fourth generation.

So when these peasant farmers manage to raise enough capital to obtain pure seeds, fertilizers and other farm input in the cultivation of NERICA and do not get good or ready market for their produce, they become de-motivated and eventually stop producing the crop.

The farmers explained during FGDs that, unlike NERICA, the other rice varieties in the study area were well known to both middlemen and consumers, which provided ready markets with high demands for them; they were easy to cultivate without adhering to any strict cultivation methods and cultural practices; and they had less production expenses due to low input requirements.

4.6.2. Prospects of NERICA Adoption in the Study Area

The respondents were asked whether they would be able to cultivate NERICA after 2014. Their responses appear to show higher prospects of NERICA adoption in the study area but they stressed that their willingness to farm was purely an individual affair. It implies that adoption is individual affair, not group behaviour. The group may influence the individual's behaviour towards adoption, but the onus rests on the individual. This position of the farmers showed that they were not willing to continue NERICA cultivation in the study area. It confirms Rogers' (2003) theory that rejection of an innovation is possible at any stage of the innovation-decision-process.

Table 4.19: Reasons for Which Farmers May Cultivate and Expand NERICA Farms after 2014

Reason	Grow NERICA		Increase Farm Size	
	98.1%		88.5%	
For food	245	64.8	153	40.5
For income	153	40.5	145	38.4
For both food and income	286	75.7	286	75.7
Seed production/availability	264	69.8	368	97.4
Have the ability/technical know how	291	77.0	145	38.4
Availability of fertile soil	286	75.7	368	97.4
Prefer NERICA to other rice varieties	145	38.4	153	40.5

Source: Field Survey, 2015

That is because even when an innovation-decision has been made, the individual looks for support for his or her decision. So the decision to adopt can be reversed if the individual is exposed to conflicting messages about the innovation or does not get enough support to confirm his or her decision. For example, if an individual decides to continue NERICA cultivation but realizes that other members in the community are no more interested in growing the crop, that individual will lack will power to stick to his or her decision due to lack of group solidarity. In homogenous societies such as the study area, many people are not so individualistic; hence they tend to adopt an innovation when they see other people in the social system adopting it. Since many farmers were no longer interested in adopting NERICA, it is likely that individual farmers interested in adopting the innovation would have to re-think their decision. The prospects of NERICA adoption in the study area are therefore very slim because what was regarded as the "magic crop" was not magical with these farmers.

Although most (98.1%) of the farmers said they would like to continue producing NERICA and 88.5% of them said they would be willing to increase their farm sizes in the future, their intention is subject to the availability of pure seeds and fertile land available for cultivation. It means that there was scarcity of pure NERICA seeds and fertile soil for NERICA cultivation in the communities as at the time of this study. This shows that their intention to continue NERICA cultivation in the near future should not be taken at its face value. The reasons for which they may like to continue to grow NERICA and expand their farms as shown on Table 4.19.

4.6.3. Conclusions on the Challenges and Prospects of NERICA Adoption

The most serious constraints farmers faced in the adoption of NERICA in the study area was insufficient finance to farm (98.1%) followed by inadequate supply of tractor and harvester services (87.8%), limited access to inputs on credit (66.7%), seed contamination (51.6%), lack of incentive for adoption of innovation (38.4%), high cost of innovation (28.6%) and lack of ready market (26.5%). Farmers in the study area were no longer interested in NERICA adoption due to the challenges stated above. This phenomenon is called active rejection of an innovation.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary of findings

This research was conducted to study the factors affecting the adoption of NERICA among rice farmers in the Tolon and Kumbungu Districts in the Northern Region of Ghana to help determine the adoption rate and suggest policy recommendation.

5.1.1. The Socio-Economic Characteristics of Respondents

The socio-economic characteristics of the respondents were examined. The study showed that NERICA passed the litmus test for Rogers (2003) innovation adoption because its perceived characteristics and characteristics of its potential adopters favoured its adoption.

The findings on sex and educational levels of the farmers revealed that although about two thirds of the farmers had no formal education, the males were more educated than the females. The study revealed that 97.8% of the famers were married, meaning that both the younger and older farmers in the study area value marriage. Crop farming was the main primary occupation of most (91.8%) of the respondents whereas animal rearing constituted the major secondary occupation (51.1%) of the farmers in the study area. The two occupations complement each other in the communities, hence many of the NERICA farmers also reared animals.

The study also revealed that farmers in their productive years (between 30 and 50 years), who also had rich experience (about 20 or more years) in rice cultivation, were involved in the NRDP. This means experienced farmers are not necessarily

older or aged farmers but business oriented people who vigorously cultivate rice during their productive years.

The average household size of the sampled farmers in the study area was 8.0, which is higher than the Northern regional average of 7.8 and the national average household size of 4.5 people. This is because communities in the study area are more agrarian and rural, and the farmers depend heavily on family labour for their farming activities than farmers in urbanized and elite communities. The literate farmers in the study area had smaller household sizes and they preferred to send their children to school and hire farm hands than the non-literate farmers. The study revealed that farmers who had no formal education took to crop cultivation as their primary occupations and they referred to themselves as "farmers" while the educated farmers preferred white colour jobs to crop farming or menial jobs.

5.1.2. Methods of NERICA Dissemination

Although a combination of individual, group and mass Extension Teaching Methods (ETMs) were used for NRDP, the study revealed that individual and group contacts were mainly used to dissemination the innovation because they were more suitable to farmers without formal education than the mass media. The main ETMs used in the project were block farms, demonstrations, awareness creation, field days, and field visits, training sessions, and study tours. Radio was the main mass medium used to create public awareness about the innovation. Community fora (meetings and discussions) were also used as a group method to sensitize the farmers about the innovation. The other group methods were the block farms, method demonstrations, field days/symposia, training sessions, and study tours/field trips. Result

demonstrations, telephone calls, home and farm/field visits were the main individual methods used.

The NRDP employed more interactive and less expensive methods to disseminate NERICA in the study area. The methods and materials used in the NRDP suited the nature of the target audience, purpose of the education, time and other resources available for the training.

More than 80% of the rice farmers interviewed during the field survey indicated that they were conversant with the methods of NERICA cultivation but they needed more support and motivation to continue cultivation. It means the farmers do not need further exposure to the methods of cultivating the 'magic crop'.

5.1.3. Adoption of NERICA in the Study Area

Adoption of NERICA in the study area occurred only in 2011 when the project support was still available to the farmers. Disadoption of NERICA occurred in 2012, 2013 and 2014 respectively. The farmers' reasons for cultivating NERICA were more personal than national or multinational reason of affirming the government's commitment to revamp the local rice sub sector, increasing gross domestic product, reducing rice import into Ghana, creating employment and improving food security. The multinational aim of the project was to improve household food security; increase farm incomes; employment creation; crop yield improvement; and enhance livelihood of household and communities that would benefit from it. Lack of personal gains such as free farm input, access to free extension services, as well as access to free tractor and harvester services from the project resulted in massive

decline in NERICA cultivation (adoption) after 2010. That attitude of the farmers was characteristic of peasant farmers who always try to benefit from aids and handouts from benevolent organizations and donor agencies.

The farmers preferred NERICA 1 to NERICA 2 because NERICA 1 had the ability to suppress weeds than NERICA 2. Another reason was that more farmers were introduced to NERICA 1 than to NERICA 2.

5.1.4 Factors Affecting the Adoption NERICA

NERICA passed the litmus test for innovation adoption because it had perceived characteristics of 68.5% relative advantage over other rice varieties in the study area, 100.0% observability, 96.7% triability, 98.9% compatibility, 16.8% complexity and 18.3% adaptability or possibility of re-invention. These perceived characteristics of the innovation, coupled with the socio-economic characteristics of the farmers favoured adoption of NERICA. However, other factors such as lack of ready market, absence of pure NERICA seeds and poor soil fertility hindered the continuous adoption of the innovation in the study area.

The regression analysis shows that farmers' educational level, household size, primary occupation and whether they thought NERICA was better than other rice varieties in the study area significantly affected their adoption of NERICA. Farmers' educational level and whether they thought NERICA was better than other rice varieties in the study area significantly and positively affected their adoption of NERICA while farmers' household size and primary occupation negatively influenced their adoption of the innovation. Farmer's age and marital status and years

of experience in rice cultivation were insignificant and therefore did not influence adoption of NERICA in the study area.

5.1.5 Challenges and Prospects of NERICA Adoption

The most important challenges farmers faced in the adoption of NERICA in the study area were insufficient finance to farm (98.1%), inadequate supply of tractor and harvester services (87.8%), limited access to inputs on credit (66.7%), seed contamination (51.6%), lack of incentive for adoption of innovation (38.4%), high cost of innovation (28.6%) and lack of ready market (26.5%). The reason was that NERICA had high input and labour requirements, which called for credit to facilitate its adoption. Lack of credit or insufficient funds to farm was a disincentive to NERICA adoption in the study area because the innovation was introduced to peasant farmers with large household sizes who could not raise adequate capital for adoption. Even though availability of land was not a constraint in the study area, there was shortage of fertile land for NERICA farming.

Most (98.1%) of the farmers said they would like to continue producing NERICA and 88.5% of them were willing to increase their farm sizes provided there were pure seeds and fertile land available for cultivation. This is a good indication for adoption but as to whether they would do it is yet another issue since they cannot do it without donor support. Though NERICA is regarded as a successful innovation, its adoption is not automatically successful or higher due to poor attitudes of farmers towards it.

5.2. Conclusions

The NERICA innovation was successfully disseminated to the communities and the methods used were appropriate hence the acceptance of the innovation during its

dissemination stage. Adoption of NERICA in the study area occurred only in 2011 when the project support was still available to the farmers. Disadoption of NERICA occurred in 2012, 2013 and 2013 respectively. Disadoption is a wilful refusal to adopt an innovation after one has earlier adopted it. This phenomenon (disadoption) is also known as *active rejection* or *discontinuous adoption* of an innovation.

The adoption of NERICA was affected by exposure, incentives, risks, and opportunity costs coupled with nature of the innovation and socio-economic characteristics of the farmers. There is more to be done after the introduction stage of an innovation to bring about adoption. It is therefore, not the best for projects to just end because they have finished their period of operation but to put structures in place for sustainability. It means innovations that are not sustainable are not worth disseminating because they would be susceptible to *active rejection (disadoption)*. *Active rejection* also means trying an innovation and thinking of adopting it but later deciding not to adopt it.

Though NERICA has its good properties it is not comparable to other varieties in the region which was shown by the inability of the producers to find market for the produce. Individual and group extension teaching methods are more suitable than mass media or indirect extension teaching methods for disseminating agricultural innovations, to less educated farmers. Mass media or indirect extension teaching methods do not work in isolation but in conjunction with direct contacts (individual and group methods) to stimulate the need for direct contacts in the target audience to seek further clarification from extension officers in the dissemination process. Farmers' views are very important in innovation communication because they help

to strengthen the existing research-extension-farmer linkage. Innovation dissemination is a collaborative effort between relevant stakeholders without whom adoption will be eluded. The reasons for disadoption of NERICA in the study area, which included scarcity of pure NERICA seeds and inadequate fertile soils in the communities, could have been addressed during the project period. Farmers' 'good intentions' or willingness to adopt or not to adopt an agricultural innovation should not be taken at its face value until their motives are made clear. The prospects of NERICA adoption in the study area are very slim because what was termed as the "magic crop" was not magical to the farmers. Adoption of NERICA therefore did not occur in the study area. The introduction of NERICA into the study area, and for that matter this country, has not reduced the importation of rice into Ghana, since 64% of rice consumed in Ghana in 2017 was imported.

5.3. Recommendations

Since NERICA was not adopted in the study are area, the following recommendations were made to help prevent such occurrences in the future:

- The government of Ghana should not invest so much money into a rice improvement project that is not the brainchild of rice farmers even if the government wants to help the rice farmers to help themselves to improve their lots. Otherwise, the farmers would take advantage of the economic gains of the project to enhance their lots and abandon the innovation at the end of the project, since they don't own it. So the request for an improved rice variety for cultivation should come from farmers who are willing and ready to partly finance and own the innovation. Their request should be made

through Extension Officers to the government, who would then consult and engage rice breeders for such an innovation.

- Any agricultural innovation aimed at improving household and national food security, reducing the importation of rice into this country and creating jobs for people in the rice sub-sector of this country should be introduced to farmers who are willing to be bonded to adopt it for a long period of time. Such farmers should be made to invest their own resources into the project as part of the agreement, to ensure their total commitment to the innovation and its sustainability.
- Since most of the farmers preferred NERICA 1 to NERICA 2, more of NERICA 1 seeds should be stored and sold to farmers who would like to cultivate NERICA in future to maintain its genetic purity and viability.
- NERICA Farmers who are credit-worthy should be assisted to access loans from the Agricultural Development Bank and other financial institutions to boost their production.
- An in-depth study should be carried out in the study area and other NRDP areas to determine the possibility of NERICA adoption in the future, to help verify the findings of this research.
- Finally, since the NRDP did not solve the problem of rice importation in Ghana, the government of Ghana should have a second look at other similar agricultural innovation dissemination projects in this country.

REFERENCES

African Development Bank (AfDB) Group, Department of Agriculture and Agro-Industry (OSAN 2) Multinational-NERICA Rice Dissemination Project (MNRDP) Completion Mission, Main Report, February 2012

AfricaRice (2016) Rice Data Systems for Sub-Saharan Africa: Contribution to the Japan- AfricaRice Emergency Rice Project, Updated Synthesis Report submitted to the Government of Japan. Africa Rice Center, Cotonou, Benin, September 30, 2016. Africa Rice Center (WARDA) (2008) NERICA: the New Rice for Africa – a Compendium, Cotonou, Benin

Akande, S.O. (1999) A study of Agricultural Research System of Nigeria, NISER Monograph Series No. 6, Ibadan: Nigeria Institute of Social and Economic Research (NISER)

Apusigah, A. A., (2004) "Empowering Women for Community Development. Revisiting the Two Imperatives of the Practical and Strategic, In Journal for Development Studies" Vol. 1 No. 1, Pp3-11

Asante, A., {2000} *Implementing Environmental Conservation Sows the Seed of Economic Progress*, In: C. Addo {ed}, Newsletter of Technoserve Ghana, No. 11, Af-Oaks Press, Accra

Asante, B.O., Wiredu, A. N., Martey, E., Sarpong, D. B., and Mensah-Bonsu, A., (2014), *NERICA Adoption and Impacts on Technical Efficiency of Rice Producing Households in Ghana: Implications for Research and Development*, American Journal of Experimental Agriculture 4(3): 244-262, 2014

Asuming-Brempong, S., Gyasi, K. O., Marfo, K. A., Diagne, A., Wiredu, A. N., Asuming-Boakye, A., Haleegaoh, J., and Frimpong, B. N., (2011) *The Exposure and Adoption of New Rice for Africa (NERICAs) among Ghanaian Rice Farmers: What is the Evidence*? In: African Journal of Agricultural Research Vol. 6(27), pp. 5911-5917

Atigah, S. S., (2010), *Agricultural Extension Services and Farmer Innovations:- The Case of the Garu Presbyterian Agricultural Station*, MPhil Thesis (unpublished), University for Development Studies, Ghana

Babbie, E., (2005) "*The Basics of Research Design*," Thomson Wadsworth, Belmont, USA

Bellon, M. R., (2001), *Participatory Research Methods for Technology Evaluation: A Manual for Scientists Working with Farmers;* CIMMYT, Mexico

Bhattacherjee, A., (2012), Social Science Research, Principles, Methods and Practices, *University of South Florida*, USA

Braak, J.V., (2001) "Individual characteristics influencing teachers' class use of computers." *Journal of Technology Education, 14*(2), 28-39, In: The Turkish Online Journal of Educational Technology – TOJET April 2006 ISSN: 1303-6521 volume 5 Issue 2 Article 3

Brown, P., (1996) "*An Introduction to Research,* Ashgate Limited, England

Bwisa, H. M., and Gakuhi, A. R., (1999) *"An Investigation into the Factors that Influence the Diffusions and Adoption of Inventions and Innovations from Research Institutes and Universities in Kenya,"* Africa Technology Policy Studies Network, Working Paper No. 19

CGIAR/Science Council, (2007) *Report of the Fifth External Program and Management Review of the Africa Rice Centre* (WARDA)

Cole, J. M., (1981) Selecting Extension Teaching Methods, Department of Agricultural and Extension Education, University of Florida-Gainesville, Accepted for Publication: May 1981

Debus, M., (1988) A Handbook for Excellence in Focus Group Research, HEALTHCOM Project special Report Series. Washington, D.C.: Porter/Novelli

DeCoster, J., (2004) Data Analysis in SPSS, Retrieved, February 14, 2016, from http://www.stat-help.com/notes.html

Diagne, A., Midingoyi, G. S. and Kinkingninhoun, F., (2009) "The Impact of NERICA Adoption on Rice Yield in West Africa: Evidence from Four Countries." Paper presented at the meetings of the International Association of Agricultural Economists Conference, Beijing, August 16–22

Diagne, A., Soul-Kifouly, G. M., Marco, W., and Inoussa, A., (2010), *The NERICA Success Story: Development, Achievements and Lessons Learned,* The Africa Rice Center (AfricaRice) B.P. 2031 Cotonou, Benin

Diagne, A. (2006), "Diffusion and Adoption of NERICA Rice Varieties in Côte d'Ivoire," *Developing Economies* 44, no. 2: 208–30

Donhauser, F., Baur, H., and Langyintuo, A., (1994) *Smallholder Agriculture in West Dagbon: A Farming System in Northern Ghana, Nyankpala Agricultural Research Report (101),* Tamale, Ghana (Unpublished)

Donkoh, S.A., and Awuni, J.A., (2011) Adoption of Farm Management Practices In Lowland Rice Production In Northern Ghana. Journal of Agricultural and Biological Science Vol. 2 (4) pp. 084- 093, July, 2011.

Donkoh, S.A., Tiffin, R., and Srinivassan, C.R., (2006) Technology adoption and Efficiency in Ghanaian Agriculture, Ph. D Thesis, (Unpublished)

Doss, C.R., and Morris, M.L., (2001) How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana, Agricultural Economics, 25, 27- 39

Enete, A. A., and Igbokwe, E.M., (2009) Cassava Market Participation Decision of Household in Africa, *Tropicultura*, 27, 3, 129-136

Fianu J.N.K., (2004), Diploma in Basic Education Studies for First Year Second Semester, ASAAD Printing and Publications, Accra

Ghana Statistical Service, (May 2012) *Population and Housing Census: - Summary Report of Final Results, (2010)*, Sokoa Press Limited, Ghana

Ghana Statistical Service (2010) *2010 Population and Housing Census*:- National Report of Final Results, Accra, Ghana Statistical Service

Ghana Statistical Service, 2013, PROVISIONAL Gross Domestic Product 2013, Available at http://www.statsghana.gov.gh/docfiles/GDP/provisional_gdp_2013.pdf [Accessed on March 12, 2014]

Glenna, L., Ader D.,, Wenda B., Abou T., and Agboh-Noameshi, R. A.,(2012), "*The Efficacy of a Program Promoting Rice Self-Sufficiency in Ghana during a Period of Neoliberalism*, The Rural Sociological Society, USA

Hasin, I., (2006) *Detailed Review of Rogers' Diffusion of Innovations Theory and Educational Technology-Related Studies Based On Rogers' Theory,* Iowa State University pp. 1-17, In: The Turkish Online Journal of Educational Technology – TOJET April 2006 ISSN: 1303-6521 volume 5 Issue 2 Article 3

http://tolonkumbungu.ghanadistricts.gov.gh/?arrow=nws&read=50191, 30/10/13

https://en.wikipedia.org/wiki/New_Rice_for_Africa, 06/05/16

https://www.ghanabusinessnews.com/2015/10/01/ghana-struggles-to-cut-rice-imports/, 25/08/16

https://www.ghanabusinessnews.com/2015/01/14/ghana-expected-to-import-600000-tons-of-rice/25/08/16

https://www.google.com.gh/search?q=map+of+Tolon/Kumbungu+with+coordinates&tbm; 30/11/17

http://www.modernghana.com/news/91801/parliament-adopt-report-on-nerica-rice-project.html, 01/05/16

http://wwwfhs (27/04/16)

https://www.newsghana.com.gh/rice-importation-costs-ghana-us-290-million/, 25/08/16

https://en.wikipedia.org/wiki/Tolon/Kumbungu_District#/media/File:Ghana_location_map.svg, 19/05/16

https://en.wikipedia.org/wiki/Regression_analysis, 06/10/16

Indian Council of Agricultural Research, (2006) *Handbook of Agriculture*, Directorate of Information and Publications of Agriculture, New Delhi

Jamison, D. T., and Peter R. M., (1984) Farmer Education and Farm Efficiency in Nepal: the role of schooling, extension services and cognitive skills, *World, Development*, 12, 67-86

Kijima, Y., Sserunkuuma, D., Otsuka, K., (2005) How Revolutionary is The "Nerica Revolution"? Evidence from Uganda, *Developing Economies*, XLIV-2 (June 2006): 252–67

Kolade, K. B., and Fakoya, E. O., (2011) Impact of Farm Credit on Farmers Socio-economic Status in Ogun State, Nigeria, In: Journal of Social Science, 26(1): 67-71 (2011)

Krejcie and Morgan (1970) Determining Sample Size for Research Activities (Educational and Psychological Measurement, #30, pp. 607-610)

Kumar, K. (1987) *Conducting Focus Group Interviews in Developing Countries*, A.I.D. Program Design and Evaluation Methodology Report No. 8. Washington, D.C.: U.S. Agency for International Development

Kumekpor, T. K. B., (2002) *Research Methods and Techniques of Social Research*, Son Life Press and Services, Accra, Ghana

Kwabena, K., (2006) *Theory in Social Research*, Accra, Ghana, Woeli Publishing Services

Lamptey, C. Y., (2006) Adoption of Yam Minisette Technique among Yam Farmers in the Central Gonja District in the Northern Region of Ghana, Bsc. Thesis, University of Cape Coast, Ghana, (Unpublished)

Larson, D.F., (2010) "*Can Africa Replicate Asia's Green Revolution in Rice?*" Policy Research Working Paper 5478, The World Bank

Law, M., Stewart, D., Letts, L., Pollock, N., Bosch, J., & Westmorland, M., (1998) Guidelines for Critical Review Form - Qualitative Studies, McMaster University

Laws, S., Harper, C., and Marcus, R., (2003) *Research for Development, A Practical Guide*, SAGE Publications, London

Light, P.C. (1998) *Sustaining innovation,* San Francisco: Jossey-Bass, In: The Turkish Online Journal of Educational Technology – TOJET April 2006 ISSN: 1303-6521volume 5 Issue 2 Article 3

Loudon, D.L. and Bitta, A.J. Della, (2002) *Consumer Behaviour,* Fourth Edition, Tata McGraw-Hill Higher Education

Martey, E., Wiredu, A. N., Asante, B. O., Anim, K., Dogbe, W., Attoh, C., Al-Hassan, R. M., (2013) Factors Influencing Participation in Rice Development Projects: The Case of Smallholder Rice Farmers in Northern Ghana, International Journal of Development and Economic Sustainability, Vol. 1, No. 2, pp. 13-27, June 2013

Mehta, L and Srinivasan, B. (2000) Balancing Pains and Gains: A Perspective Paper on Gender and Large Dams. Prepared for Thematic Review I, 1, Institute of Development Studies, UK

Merrill-Sands, D. (1992) Managing links with technology users: A training module. The Hague: International Service for National Agricultural Research.

Millar, D., (2008) *Farmers' Experimentation: An alternative Logic*, GILLBT Printing Press, Tamale, Ghana

Ministry of Food and Agriculture, Ghana (2011): *NERICA Rice Dissemination Project, Project Terminal and Exit Strategy Report (2005-2010)*

Ministry of Food and Agriculture (2011) Project Progress Report, Nerica Rice Dissemination Project, 2011 Annual Report, Tolon/Kumbungu District, Northern Region, Ghana (Unpublished)

Ministry of Food and Agriculture (2010) Project Progress Report, Nerica Rice Dissemination Project, Third Quarter Report, January–December 2010, Tolon/Kumbungu District, Northern Region, Ghana (Unpublished)

Ministry of Food and Agriculture (2010), Project Progress Report, Nerica Rice Dissemination Project, 2010 Annual Report, Tolon/Kumbungu District, Northern Region, Ghana (Unpublished)

Ministry of Food and Agriculture (2009), Project Progress Report, Nerica Rice Dissemination Project, 2009 Annual Report, Tolon/Kumbungu District, Northern Region, Ghana (Unpublished)

Ministry of Food and Agriculture-DADU, (2007) *Livestock Development Project in Ghana: Policies and Strategies,* Accra, Ghana (Unpublished)

Ministry of Food and Agriculture, (2006) *Agricultural Extension Handbook*, AgSSIP and CIDA Farmer Project, Tamale, Ghana

Morris, M. L., and Doss, C. R., (1999) *"How Does Gender Affect the*

Adoption of Agricultural Innovations? The Case of Improved Maize Technology in Ghana" (Unpublished)

Morris, M.L., Tripp, R., and Dankyi, A.A., (1999) Adoption and Impacts of Improved Maize production Technology: A Case Study of the Ghana Grains Development Project, Mexico, D.F.: CIMMYT

Nchor, J., (2011), *Indigenous Knowledge in Small Ruminant Livestock Rearing and Its Implications for Food Security in the Tolon-Kumbungu District in the Northern Region of Ghana,* MPhil Thesis, Department of Africa and General Studies, Faculty of Integrated Development Studies, UDS, Ghana (Unpublished)

Nelemaghan, A., (1981) Some Issues in Information Transfer: - A Third World Perspective. *IFLA Journal 7*(1), 8-18

Nyarko, P., (2012) *Population and Housing Census: - Provisional Results, (2010),* Ghana Statistical Service, Sokoa Press Limited, Ghana

Obeng, F. K., (2013), *Development of Extension Training Materials, MPhil Innovation Communication Lecture Notes*, Faculty of Agriculture, UDS Nyankpala campus, Ghana (Unpublished)

Ofori, I.M., (1973) Factors of Agricultural Growth in West Africa. ISSER, University of Ghana, Legon, Accra, Ghana

Okunmadewa F.O., (1999) Livestock industry as tool for poverty alleviation. *Tropical Journal of Animal Science,* 2 (2): 21-30

Osuala, E., (2001) *Introduction to Research Methodology*, Onisha, Nigeria, Africana-First Publishers

Pingali, P. L., Rozelle, S. D. and Gerpacio, R. V., (2001) *The Farmer's Voice in Priority Setting: - A cross-Country Experiment in Eliciting Technological Preferences; Economic Development and Cultural Change*; 49(3):591-609

Prakashkumar, T., (2016) ICAR JRF/SRF Study Material on Extension Education, Department of Veterinary and H. A. Extension Education, Veterinary College, Bidar (Karnataka)

Rathod K., (2016), Classification of Extension Teaching Methods, Department of Veterinary and H. A. Extension Education, Veterinary College, Bidar (Karnataka)

Renkow, M., and Byerlee, D., (2010) *The Impacts of CGIAR research: A review of recent experience*, Food Policy (2010), doi:10.1016/j.foodpol.2010.04.006

Rogers, E. M., (2003) *Diffusion of Innovations*, (5th Ed), The Free Press, New York

Science Council, (2007) *Report of the Fifth External Program and Management (EPMR) of the Africa Rice Centre (WARDA*), Consultative Group on International Agricultural Research (CGIAR), Science Council Secretariat, Rome

Schultz, T. W., (1945) *Agriculture in an unstable Economy*. McGraw-Hill Book Company Inc., New York

Seidu, I., (2011) *The Effects of Agricultural Modernization on Poverty Reduction: A Case Study of the Tono Irrigation Scheme in the Kasena-Nankana District of the Upper East Region of Ghana,* MPhil Thesis, University for Development Studies, Ghana (Unpublished)

Sezgin, A., Kaya, E. T., Murat, K., and Hediye, K., (2011) Factors Affecting the Adoption of Agricultural Innovations in Erzurum Province, Turkey, In African Journal of Business Management Vol.5 (3), pp. 777-782, 4 February, 2011

Sindi, J.K., (2008) "Kenya's Domestic Horticulture Subsector: What drives Commercialization Decisions for Rural Households?" A Published MPhil Thesis for the Award of Master of Science Degree, Department of Agricultural, Food, and Resource Economics: Michigan State University

Southworth, H. M., and Johnston, B. F., (1967), *Agricultural Development and Economic Growth*, Cornell University Press, U.K

Sperling, L., Levisohn, M. E. and Ntabomvura, B., (1993) *Rethinking the Farmer's Role in Plant Breeding: Local Bean Experts and On-Station Selection in Rwanda, Experimental Agriculture*; 29:509-519; Eyzaguirre, P. and Iwanga, M., (Eds.) {1996}; Participatory Plant Breeding, Proceedings of a Workshop on Participatory Plant Breeding, July 26-29, 1995, Wageningen, The Netherlands, IPGRI, Rome, Italy

Sunding D., and Zilberman, D., (2000) The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector, California, USA

Surry, Daniel W., (1997) Diffusion theory and instructional technology, Retrieved February 3, 2014 from http://www2.gsu.edu/wwwwitr/docs/diffusion

Swanson, B. E., (1993) *Identifying linkage problems using systems analysis: A training module,* Urbana, IL: International Program for Agricultural Knowledge Systems

Taborn, J., (2011) *Adoption of Agricultural Innovations, Converging Narratives, and the Role of Swedish Agricultural Research for Development,* Sweden

Taxler, G. and Byerlee, D., A Joint-Product Analysis of the Adoption of Modern Cereal Varieties in Developing Countries; America Journal of Agriculture Economics; 75:981-989; 1993

Tolon-Kumbungu District Assembly brochure, (2001) Northern Region, Ghana

Twumasi, P. A., (2001) *Social Research in Rural Communities*, Ghana University Press, Accra, Ghana

Umunna, N. O., (2010) Personal and Socio-Economic Determinants of Agricultural Information Use by Farmers in the Agricultural Development Programme (ADP) Zones of Imo State, Nigeria

US Department of Health and Human Services (1980) *Pretesting in health communications: Methods, examples, and resource for improving health messages and materials*, Bethesda, MD., US.A, National Cancer Institute

WARDA, (2008) *NERICA Adoption and Impact: Summary of findings from four countries:- Research and Development Brief*, WARDA

WARDA, (2003) *NERICA Adoption and Impact: Summary of findings from four countries:- Research and Development Brief*, WARDA

Weir, S. and Knight, J., (2000) Adoption and Diffusion of Agricultural Innovations in Ethiopia: The Role of Education, JEL Classification: D62, I2, O33, Q16

Wiredu, A. N., Gyasi, K. O, Marfo K. A., Asuming-Brempong S, Haleegoah, J., Asuming-Boakye, A, Nsiah B. F., (2010), Impact of improved varieties on the yield of rice producing households in Ghana, Second Africa Rice Congress, Bamako, Mali, 22–26 March 2010

www.afdb.org, 01/05/16

www.afdb.org/.../Multinational_New_Rice_for_Africa__NERICA__Dis.., 05/05/16

www.ghanadistricts.com, 30/10/13

www.savannahagriculturalresearchinstitute.org, 30/10/13

Yamane, T., (1967) *Statistics: An Introductory Analysis*, 2nd Ed., New York: Harper and Row

Yin, R. K., (1994) *Case Study Research Design and Methods*, SAGE Publications, New Delhi

Yoko, K., (2008) *New Technology and Emergence of Markets: Evidence from NERICA Rice in Uganda*, Graduate school of International Development (GSID), Discussion paper No. 165, Nagoya University, Nagoya, Japan

APPENDIX A

UNIVERSITY FOR DEVELOPMENT STUDIES
Faculty of Agribusiness and Communication Sciences, Nyankpala Campus

Student Thesis Topic:
ADOPTION OF NERICA AMONG RICE FARMERS IN TOLON AND KUMBUNGU DISTRICTS, NORTHERN REGION, GHANA

A SURVEY QUESTIONNAIRE FOR COLLECTING PRIMARY DATA FROM RICE FARMERS IN TOLON AND KUMBUNGU DISTRICTS

(I) SOCIOECONOMIC CHARACTERISTICS OF FARMERS

1. District: ……..... 2. Community: ……

3. Name of farmer ……4. Contact No…….....

5. Sex of farmer (a) Male (b) Female

6. Age of farmer (a) Below 30 Years (b) 30-39 Years (c) 40 – 49 Years

(d) 50 – 59 Years (e) 60 Years and Above

7. Marital status of farmer (a) Single (b) Married (c) Divorced

(d) Separated (e) Widowed

8. Education level **completed** (a) No/Non-formal Education (b) Basic/Elementary Education (c) Second Cycle Education (d) Tertiary Education

9. Number of people in farmer's household (a) 1-3 (b) 4-6 (c) 7-9

(d) 10-12 (e) Above 12

10. Farmer's primary occupation (a) Salaried Worker (b) Artisan (c) Crop Farming (d) Animal Rearing (e) Trader (f) Weaving (g) Shea Processing(h) Groundnut Processing (i) Other (specify) ……

11. Farmer's secondary occupation (a) Salaried worker (b) Artisan (c) Crop farming (d) Animal Rearing (e) Trader (f) Weaving (g) Shea Processing (h) Groundnut Processing (i) Other (specify) …….....

12. For how long have you been cultivating rice? (a) Below 5 Years (b) 6 to 10 Years (c) 11 to 15 Years (d) 16 to 20 Years (e) 21 Above 20 years

(II) INNOVATION DISSEMINATION METHODS USED IN THE DISTRICTS

13. How did you get to know about NERICA Rice? Through: (a) NERICA Project Staff (b) Mass Media (c) Other Farmers (d) Market Women (e) Other (specify)

…….....

14. Which year were you introduced to NERICA cultivation? .....

15. Please indicate whether any of the following methods of innovation dissemination was used to introduce the NERICA varieties to you.

Innovation Dissemination Method	**1. Yes**	**2. No**	**How each method helped understand the innovation?**	**Why do you say so? Please, give a reason for each of your responses in the table above.**
Experimental plots				
Demonstrations				
Awareness Creation/ Campaign: Radio, Television, Meetings				
Field Days				
Supervisory Visits/ Farm and Home Visits				
Training Sessions				
Study Tours/Field Trips/Conducted Tours				
Farmer field schools				

Answer: (1) Not at All (2) **Somehow (3) Much (4) Very Much**

16. What do you think the NRDP could have done better to help you know much about NERICA?

a).....

b).....

c).....

17. Please indicate whether any of the of innovation dissemination methods that was used to introduce the NERICA varieties to you are still available in the districts.

Innovation Dissemination Method	**1. Yes**	**2. No**	**How are you exposed to each of these processes now?**	**Why do you say so? Please, give a reason for each of your responses in the table above.**
Experimental plots				
Demonstrations				
Awareness Creation/ Campaign: Radio, Television, Meetings				
Field Days				
Supervisory Visits/ Farm and Home Visits				
Training Sessions				
Study Tours/Field Trips/Conducted Tours				
Farmer field schools				

Answer: (1) Not at All (2) **Somehow (3) Much (4) Very Much**

(III) ADOPTION OF NERICA

18. Do you grow other types of rice apart from NERICA? (a) Yes (b) No

19. What variety of rice and size of farm did you cultivate in the past years?

Year	NERIC1 Farm size	NERICA2 Farm size (Acres)	Other Rice Variety Name	Farm size (Acres)	Other Rice Variety name	Farm size (Acre)
2006						
2007						
2008						
2009						
2010						
2011						
2012						
2013						
2014						

20. What were the outputs and prices of the various varieties you cultivated as indicated in the table above?

Year	NERICA N1 output	Price per bag of N1	NERICA N2 output	Price per bag of N2	Other Rice output 1	Price per bag of other	Other Rice Output 2	Price per bag of other

2006								
2007								
2008								
2009								
2010								
2011								
2012								
2013								
2014								

21. Why do you cultivate other types of rice apart from NERICA?

……

……..……

……..……

22. Please, state three good characteristics the other rice varieties have that the NERICA does not have.

a).....

b).....

c).....

23. Cultivation of NERICA: Seeds and Grains

Cultivation of NERICA	**1.Yes**	**2. No**	**NERICA Seeds/Grains**	**Why do you say so? Please, give a reason for each of your responses in this table.**
Have you grown NERICA Rice on your farm, after the dissemination process (2010)?				
Which of the following years did you grow NERICA in your farm, after the dissemination period (2010)?			(1) 2011 (2) 2012 (3) 2013 (4) 2014	
Will you continue to grow NERICA after 2014?				
Will you increase your NERICA farm in the coming				

years?				

Answer: NERICA Cultivation (1) Seed Growing (2) Grain Growing (3) Both Seed and Grain Growing

24. Would you like advise other rice farmers to grow NERICA? [ ] Yes [ ] No

25. If 'yes', why?

……

……

26. If 'no', why?

……

……..

27. Which of the NERICA varieties was introduced to you? (a) N1 (b) N2 (c) N1 & N2

28. Which of the NERICA varieties did you like most? (a) N1 (b) N2 (d) None of them

29. Why do you like the NERICA variety chosen most? Choose from the following attributes/characteristics?

Attributes/characteristics	**1. Yes**	**2. No**
Drought resistant		
Early maturity		
Good grain quality		
Good taste		
Low grain yield		
Short Straw		
Low input requirements		
High grain yield		
It is a lowland/upland rice		
Increased productivity		
Reduced grain loss due to processing		
Good cookability		
Increased palatability		
Nice aroma		
It has ready market/good market price		

30. Kindly state any other characteristics of the variety you liked which is not among the list in the table above.

(a) ……....

(b) ...…….....

(c) ……

(V) FACTORS AFFECTING ADOPTION OF NERICA IN TOLON AND KUMBUNGU DISTRICTS

31. Do you think the NERICA is better than the other rice varieties in your district?

[ ] Yes [ ] No

32. If yes, what makes it better than the other rice varieties in the community?
.....
.....

33. Were you able to use the same tools, equipment, machines and chemicals that you normally use to cultivate other rice varieties to grow the NERICA?

[ ] Yes [ ] No

34. Did you have the opportunity to grow the NERICA on a small scale (plot) before finally deciding to grow it on large scale (plot of farm land)? [ ] Yes [ ] No

35. Were you able to see the performance of the NERICA on the demonstration farms before deciding to try it on your own? [ ] Yes [ ] No

36. In whose farm did you see the performance of the NERICA before deciding to grow it yourself? (a) Demonstration farms of the AEAs (b) Others farmers' farms in the community (c) Both the demonstration farms and those of other farmers (d) None of the above

37. How would you describe the methods of growing the NERICA? (a) Easy (b) Very Easy (c) Complex (d) Very Complex

38. Do you think you can change the way the NERICA plant looks like to suit the way you want it? [ ] Yes [ ] No

39. If your answer in the above is 'yes', please state why it can be changed.

.....
.....

40. If your answer in the above is 'no', please state why it cannot be changed.
.....
.....

41. Can you change the way the NERICA is grown to suit the way you want it?

[ ] Yes [ ] No

42. If your answer in question 41 above is 'yes', please indicate how it can be done.

..……
……

43. If your answer in question 41 above is 'no', please state why it cannot be done.

……
……

44. Why are you still cultivating NERICA?

a) .....
b).....
c).....

45. Why are you no more cultivating NERICA?

a).....
b).....
c).....

46. Why are some of the farmers you started cultivating NERICA with stopped cultivating it?

a) .....
b).....
c).....

IV CHALLENGES AND PROSPECTS OF NERICA ADOPTION

47. To what extent will you consider each of the following factors as constraint to your adoption of the NERICA?

Factor	**Not a Constraint**	**Mild Constraint**	**Serious Constraint**
Unstable market price (either high or low)			
Lack of ready market for produce			
Insufficient finance to farm			
Inadequate access to extension services/personnel			
High cost of innovation such as "labour intensiveness"			
Lack of production skills or technical know how			
Inadequate supply of tractor and harvester services			
No subsidies on input prices			
Shortage of land for farming			
Poor soil fertility			
High disease attack (not resistance to diseases)			
Failure of extension workers to reach farmers			
Lack of incentive for adoption of innovation			

Limited access to inputs on credit			
Non-membership of cooperatives and other rural organizations			
Bureaucracy/Institutional arrangements (delays)			
Cultural/Religious/Political interferences			
Variety not known to farmers			

48. Kindly state any other factor(s) you consider as constraints to your adoption of NERICA in the district.

(a) ……
(b) ……
(c) ……

49. Kindly state some of the resources in the community that can help you in case you want to grow NERICA after 2014?

(a) ……
(b) ……
(c) ……

APPENDIX B

UNIVERSITY FOR DEVELOPMENT STUDIES

Faculty of Agribusiness and Communication Sciences, Nyankpala Campus

Student Thesis Topic:

ADOPTION OF NERICA AMONG RICE FARMERS IN TOLON AND KUMBUNGU DISTRICTS, NORTHERN REGION, GHANA

INTERVIEW GUIDE FOR COLLECTING PRIMARY DATA FROM NERICA FARMERS IN TOLON AND KUMBUNGU DISTRICTS

1. Please, could you explain how you became a NERICA farmer?
2. Please indicate which methods of innovation dissemination were used to introduce NERICA to you and state why each of them helped you.
3. What do you think could have been done better to help you know much about NERICA?
4. Have you grown NERICA on your farm, after the project ended in 2010?
5. Which year did you grow NERICA in your farm, after the project ended in 2010?
6. What are some of the benefits of NERICA farming?
7. What are some of the challenges of NERICA farming?
8. Please, are you still using the methods of cultivating NERICA to grow rice?
9. Will you grow NERICA after 2014?
10. What advice do you have for SARI about NERICA farming?

APPENDIX C

UNIVERSITY FOR DEVELOPMENT STUDIES

Faculty of Agribusiness and Communication Sciences, Nyankpala Campus

A GUIDE FOR FOCUS GROUP DISCUSSION WITH NERICA FARMERS IN TOLON AND KUMBUNGU DISTRICTS

1. Probe into innovation dissemination processes used to introduce the NERICA varieties to farmers and how each process helped them.
2. Let farmers indicate whether they are you still using the methods of cultivating NERICA to grow rice.
3. Find out the NERICA variety farmers liked most and reasons for that.
4. Find out if farmers have cultivated NERICA on your farms, after the project ended in 2010.
5. Let farmers give reasons for cultivation or not cultivating NERICA on their farms after 2010.
6. Let farmers indicate the specific year (s) they actually cultivated NERICA in their farms, after the project ended in 2010.
7. Examine farmers' reasons for the specific year (s) they actually cultivated NERICA in their farms after the project ended.
8. Find out whether the farmers would continue to grow NERICA after 2014?
9. Elicit from the farmers the challenges of NERICA cultivation.
10. Examine the prospects of NERICA farming after 2014.