UNIVERSITY FOR DEVELOPMENT STUDIES

CONTRACT FARMING AND ADOPTION OF IMPROVED TECHNOLOGIES IN MAIZE PRODUCTION IN THE NORTHERN REGION OF GHANA

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CONTRACT FARMING AND ADOPTION OF IMPROVED TECHNOLOGIES IN MAIZE PRODUCTION IN THE NORTHERN REGION OF GHANA

BY

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THESIS SUBMITTED TO THE DEPARTMENT OF AGRICUTURAL AND RESOURCE ECONOMICS, FACULTY OF AGRIBUSINESS AND COMMUNICATION SCIENCES, UNIVERSITY FOR DEVELOPMENT STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN AGRICULTURAL ECONOMICS

FEBRUARY, 2017

DECLARATION

STUDENT DECLARATION

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:

Student's Signature………………………………….. Date………………………

Name: Musah Abdul-Rahman

SUPERVISOR'S DECLARATION

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.

Supervisor's Signature………………………………… Date………………………

Name: Dr. Samuel A. Donkoh

Head of Department's Signature……………………… Date………………………

Name: Dr. Samuel A. Donkoh

ABSTRACT

This study examined contract farming and adoption of improved technologies in maize production in the Northern region of Ghana. The objectives were to: identify the improved farm technologies (IFTs) being adopted in the study area and measure the extent of adoption; examine the factors influencing the adoption of IFTs; assess how participation in contract farming (CF) affect adoption of IFTs; investigate the factors influencing participation in CF as well as the problems faced by maize farmers. A total of 300 maize farmers were selected through multi-stage sampling procedure. Multivariate probit model, Poisson model with endogenous treatment, Probit model and Kendall's coefficient (W) were used. The improved technologies were herbicide use for land preparation, improved varieties, row planting and maize-legume rotation. The factors that positively and significantly influenced the adoption of IFTs were extension visit, land tenure, farm size, contract farming and age of farmers. Credit, membership of farmer based organisation and household size were significant but negative. Meanwhile, education, attitude towards risk, access to credit and interest rate all positively influenced participation in contract farming in the study area. The most pressing constraint associated with maize farming in the study area was high cost of inputs. This was followed by lack of access to credit and lack of improved varieties, among others. The study recommends that Government, NGOs, Institutions etc. should step up in increasing access to extension visit, contract farming, education, credit, land, as well as inputs. Farmers should also be encouraged and supported to go into contract farming.

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DEDICATION

This work is dedicated to my wife, Alhassan Afilua (Hafsah) and my children, Sa-Ad, Saeed and Salmah for their unmatched support.

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LIST OF ABBREVIATIONS

ADRA	Adventist Development and Relief Agency
BOST	Bulk Oil Storage and Transport
CDC	Commonwealth Development Corporation
CF	Contract Farming
CFAs	Contract Farming Arrangements
CFRC	Contract Farming Research Center
CIMMIYT	Centro Internacional de Majoramiento de Maíz y Trigo
FAO	Food and Agricultural Organisation
FBO	Farmer Based Organisation
GDP	Gross Domestic Product
GHK	Gaweke-Hajiuassiliou-Keane
GLSS	Ghana Living Standard Survey
GSS	Ghana Statistical Service
IFC	International Finance Corporation
IFTs	Improved Farm Technologies
IMR	Inverse Mill's Ratio
ISSER	Institute of Social, Statistical and Economic Research
LDC	Less Developed Country
MoFA	Ministry of Food and Agriculture
MVP	Multivariate Probit
NGO	Non- Governmental Organisation
SADA	Savannah Accelerated Development Authority
SAP	Structural Adjustment Programme
SARI	Savannah Agricultural Research Institute

SAVACEM	Savannah Cement
SFMC	Savannah Farmers Marketing Company
SG	Sasakawa Global
SPSS	Statistical Package for Social Science
SRID	Statistical Research and Information Directorate
USAID	United States Agency for International Development

CHAPTER ONE

INTRODUCTION

1.0 Background of the Study

Agriculture in Africa is dominated by smallholder farmers who occupy the majority of land and produce most of the crop and livestock products (Adeleke *et al*., 2010). Until recently, the African agricultural landscape was characterized by sluggish growth and low factor productivity. Since the late 1970s to mid 1980s, many African countries have implemented macroeconomic, sectoral and institutional reforms aimed at ensuring high and sustainable economic growth, food security and poverty reduction. Despite the number of sound agricultural policies adopted, the sector's growth remained insufficient to adequately address poverty, attain food security, and lead to sustained Gross Domestic Product (GDP) growth on the continent (Dessy *et al*., 2006, and World Bank, 2008). For this reasons, diverse agricultural technologies have been released to farmers because they have the potential to improve their productivity (Akudagu *et al*., 2012).

In Ghana, agriculture plays a key role to the growth of the economy. The sector's contribution to Gross Domestic Product (GDP) was 22 percent in 2013 (GSS, 2013). Agriculture's contribution to total employment is estimated to be 53.0% (FAPDA, 2014). The sector also provides food, raw materials for the industries and generates income for households from production to the sales of the products (MoFA, 2009). The sector is dominated by smallholder farmers. About 90 percent of farms are less than 5 acres in Ghana. Rural population constitutes 49.1% of total population in Ghana (GSS, 2010).

Contract farming is a system for production and supply of agricultural or horticultural produce under forward contracts between producers or suppliers and buyers (Haque, 2000). It is a case of bringing the market to the farmers, which is directed by agribusiness firms (Christensen and Scott, 1992). The contractual agreement encompasses three areas: (i) Market provision: the grower and buyer agree for future sale and purchase (ii) Resources provision: the buyer agrees to supply inputs and technical advice and (iii) Management specifications: the growers agree to follow the recommended package of practices for crop cultivation (Wright, 1989). Wide support has been received for contract farming under the Structural Adjustment Programme (SAP) and liberalization policies by the international development agencies like World Bank, United States Agency for International Development (USAID), International Finance Corporation (IFC) and Commonwealth Development Corporation (CDC) (Little et al. 1994; White, 1997).

Adoption is the integration of innovation into farmers' normal farming activities over an extended period of time (Dasgupta, 1989). Adoption can be classified into individual level adoption and aggregate level adoption. While the individual level is the degree of use of new technology in long run equilibrium, the latter is the spread of new technology in a region (Feder *et al.*, 1985). The development of appropriate agricultural technology assumes critical importance, the magnitude of which is reflected in the desire to adopt such innovations by the developing countries. According to Feder et al., (1985), adoption of technological innovations in agriculture has attracted considerable attention among development economists. This is because the majority of the people in less developed countries (LDCs) derive their livelihood from agricultural production and new technologies seem to offer an opportunity to increase production and income substantially. It is therefore imperative that delivery of such technologies be accorded priority attention. The available literature on the adoption process gives different perspectives. According to Misra (1990), farmers' adoption is about their acceptance of an innovation. Adoption is a slow process depending on the nature of the innovation, farmers' level of understanding and competence of the delivery systems. There is a time lag between technology development and its adoption. Sall *et al.*, (2000), suggested that two decades is about the time frame that technologies take to develop from the research stage to widespread implementation. According to Onyx and Bullen (2000), adoption is positively related to certain factors such as farm size, education and living standards, farm information such as radio and extension. Onyx and Bullen (2000) further asserted that innovation attributes of the technology such as relative advantage, adoptability, and compatibility and trial ability are also believed to bear relationship with its adoption, but that what is most needed for farmers to adopt is appropriateness of the technology.

Awika (2011) reported that cereal grains such as rice, maize and wheat have been part of human diet and are believed to have contributed significantly to shaping human civilization. According to the food and agricultural organization (FAO, 2002), the majority of the world's population depend on cereals as the most important source of food and energy. In Ghana, household expenditure on cereals alone accounts for more than 23% of household total spending on food (Ghana living standards survey report, 2008). Among the variety of cereal grains, maize is one of the single most important source of calories. In terms of production, maize is one of the three grains that account for more than 50% of the world's production of cereals (Awika, 2011). Of all the major grain food crops found in Ghana; for example, rice, millet, wheat and sorghum; maize (zea mays) is considered to be the most important grain food (MoFA, 2009; FAO, 2008).

According to the Savannah Agricultural Research Institute (SARI, 1996), maize is produced predominantly by smallholder resource poor farmers under rain-fed conditions. Low soil fertility and low application of external inputs are the two major reasons that account for low productivity in maize. The soils of the major maize growing areas in Ghana are low in organic carbon (<1.5%), total nitrogen (<0.2%), exchangeable potassium (<100 mg/kg) and available phosphorus (< 10 mg/kg) (Adu, 1995, Benneh et al.1990).

Maize grains have great nutritional value as they contain 72% starch, 10% protein, 4.8% oil, 8.5% fibre, 3.0% sugar and 1.7 % ash (Chaudhary, 1983). Maize is the most important cereal fodder and grain crop under both irrigated and rain fed agricultural systems in the semi-arid and arid tropics (Hussan *et al*., 2003). According to SRID-MOFA (2010), the per capita consumption of maize in Ghana in the year 2010 was estimated at 43.8kg and an estimated national consumption of 1,052,100 Mt in 2015 as reported by SRID-MOFA (2010).

1.1 The Statement of the Problem

In much of Sub-Saharan Africa, agriculture is a strong option for spurring growth, overcoming poverty, and enhancing food security. Of the total population of Sub-Saharan Africa in 2003, 66% lived in rural areas and more than 90% of rural people in these regions depend on agriculture for their livelihoods (WDR, 2008). Improving the productivity, profitability, and sustainability of smallholder farming is therefore the main pathway out of poverty in using agriculture for development (WDR, 2008). Achieving agricultural productivity growth will not be possible without developing and disseminating yield-increasing technologies because it is no longer possible to meet the needs of increasing numbers of people by expanding areas under cultivation (WDR, 2008). Agricultural research and technological improvements are therefore crucial to increase agricultural productivity and thereby reduce poverty and meet demands for food without irreversible degradation of the natural resource base (World Bank, 2007).

The adoption of new agricultural technology such as improved seed is important to agricultural growth and poverty reduction, considering their effect of increasing agricultural productivity, and hence food self sufficiency (Minten, 2008). For instance, Sasakawa Global 2000 (2002) found that maize productivity in Western Ethiopia increased from 1.6 tons per hectare to 5.4 tons per hectare in 1993, mainly due to a higher adoption of improved seed and fertilizer. Clearly, adoption of improved farm technologies has the power to improve household welfare (Becerril and Abdulahi, 2010). Even though the adoption of new technologies is believed to improve the welfare of the poor through enhancing agricultural productivity, the rate and level of improved technology adoption is far below what is expected due to many interrelated problems (World Bank, 2008). The causes of low and fluctuating adoption rate is expressed by a number of attributes ranging from farmer and farm related characteristics to attributes related with the technology itself, perception of its profitability and other socio economic factors.

The existence of high poverty levels in Northern Region coupled with food insecure households, has attracted many development partners, donor agencies, NGOs and private sector actors to establish many development oriented programmes in the region (Shaibu, 2015). One of these important interventions that is often overlooked is contract farming. Studies have confirmed improvement in farmers' income as a result of participation in contract farming (Key and Runsten, 1999, and Warning and Key, 2002). Contract farming has considerable potential for integrating smallholders in to export and processing markets, and into the modern economy (Kirsten & Sartorius, 2010; Wang, Wang, & Delgado, 2014). There is also evidence that show situations where farmers received limited gains from participating in contract farming (Key and Runsten, 1999 and Simmons *et al.*, 2005). Contract farming is taken as one of the strategies for enhancing production efficiency and enhancing marketing access for small farming business.

There are a number of companies or organisations (i.e. SADA, ADRA, SFMC etc.) that contract farmers to cultivate crops in the study area. To the best of my knowledge, I have not come across a work on effect of contract farming on the adoption of improved technologies among maize farmers.

This study is therefore designed to provide empirical information on the participation of contract farming and its effect on improved technology adoption among maize farmers in the Northern Region of Ghana

1.2 Research Question

This study seeks to find answers to the following questions:

1. What agricultural technologies are being adopted by Maize farmers in the Northern region of Ghana and what is the extent of adoption?
2. What factors influence the adoption of improved farm technologies?
3. How does participation in contract farming affect the adoption of improved farm technologies?
4. What are the factors that the influence participation in contract farming?
5. What are the constraints faced by maize farmers in the study area?

1.3 Objectives of the Study

1.3.1 Main objective

The main objective of the study is to analyze the participation in contract farming and its effect on technology adoption among maize farmers in the Northern Region of Ghana.

1.3.2 The specific objectives

The specific objectives are to:

1. Identify the improved agricultural technologies being adopted in the Northern region of Ghana and measure the extent of adoption;
2. Investigate the factors that influence the adoption of improved technologies;
3. Measure the effect of contract farming participation on the adoption of improved technologies;
4. Examine the factors influencing farmers' participation in contract farming; and
5. Explore the constraints facing maize farmers in the study area.

1.4. Significance of the Study

In order to boost the adoption of improved technologies, stakeholders participating in contract farming and the overall adoption process have to understand all the possible factors that influence contract farming participation and technologies adoption so that they can respond to the farmers accordingly.

The result of this research will be helpful for extension workers, cooperative unions, development agents, other NGOs in order to work on the relationships established and gaps identified so as to take a quick response. It would also be helpful for policy makers to redirect resources used for intervention (extension, credit, demonstration, subsidy scheme) in accordance with the gap.

1.5 Organization of the Study

The thesis is put into five chapters. Chapter one covers the background of the study, problem statement, research questions, research objectives and justification. Chapter two presents a review of the literature relevant to this study. Chapter three highlights the research methodology which describes the theoretical support or underpinnings and its empirical application; the sampling technique, type of data collected and a brief description of the study area as well as data analysis techniques employed in the analysis of the data. Chapter four covers results and interpretation while chapter five looks at summary of findings, conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviews literature related to the area under study. It reviews studies conducted in other parts of the world and the type of statistical and econometric analysis employed. The chapter touches on agricultural production in Ghana, definition of adoption and diffusion of agricultural technologies. It also looks at adoption categories, adoption stages, empirical literature review on farm technology adoption, as well as theoretical and empirical studies on contract farming.

2.1 Definition of Adoption and Diffusion of Agricultural Technologies

According to Dasgupta (1989), adoption is defined as the integration of an innovation into farmers' normal farming activities over an extended period of time. It does not refer to a permanent behaviour since a farmer may decide to discontinue the use of an innovation for a variety of personal, institutional, and social reasons one of which might be the availability of another practice that is better in satisfying farmers' needs (Dasgupta,1989).

According to Feder *et al*., (1985), adoption is classified as an individual (farm level) adoption and aggregate adoption. The farm level adoption refers to the degree of use of new technology in long run equilibrium when the farmer has full information about the new technology and its potential, whilst aggregate adoption refers to the spread of new technology within a region and is measured by the aggregate level of specific new technology with a given geographical area or within the given population. According to Singh (2005), contract farming can be defined as a system for the production and supply of agriculture and horticultural produce by farmers or primary producers under advance contracts, the essence of such arrangements being a commitment to provide an agricultural commodity of a type, at a specified time, price, and in specified quantity to a known buyer. Adoption starts from hearing about an innovation or technology to final adoption decision indicating that it is not a sudden event. Adoption is a process since farmers do not accept innovations immediately until they take time and think over things before reaching a decision as stated by Rogers (1983).

The rate of adoption is defined as the number or percentage of farmers who have adopted a given technology. According to Lionberger (1960), adoptions are very slow at first, increase at an increasing rate until approximately half of the potential adopters have accepted the change. After this, acceptance continues, but at a decreasing rate indicating that the rate of adoption follows S-shaped curve.

On intensity of adoption, Nkonya (1997) defines intensity of adoption as the amount of input applied per hectare as compared to the total land. In general, the intensity of adoption is defined as the level of adoption of a given technology. The number of hectares planted with improved seed (also tested as the percentage of each farm planted to improved seed).

According to Roger and Shoemaker (1971), it takes time for an innovation to diffuse through a social system. It is not realistic to expect that all farmers in a community will adopt an innovation or a technology immediately after its introduction as there is always a variation among the members of a social system in the way they respond to innovative idea.

Dasgupta (1989), stated that there are always a few members in a social system who are so innovative that they adopt an innovation almost immediately after they come to know about it, while the majority take a long time before accepting the new idea or practice. In addition, people adopt the innovation in an ordered time sequence, and they may be classified into adopter categories on the basis of when they first begin using the new idea. According to Dasgupta (1989), although farmers often reject an innovation instead of adopting it, non-adoption of an innovation does not necessarily mean rejection as farmers are sometimes unable to adopt an innovation, (probably because of economic and situational constraints) even though they have mentally accepted it.

2.2 Conceptual Framework of the Study

Agricultural technology adoption often varies from location to location. In general, the variations in adoption patterns proceed from the presence of disparity in agro ecology, institutional and social factors (CIMMIYT, 1993). Moreover, farmers' adoption behaviour, especially in low-income countries, is influenced by a complex set of socio-economic, demographic, technical, institutional and biophysical factors (Legesse, 2001).

Adoption rates were also noted to vary between different groups of farmers due to differences in access to resources (land, labour, and capital), credit, and information as well as differences in farmers' perceptions of risks and profits associated with new technology (Tesfaye and Alemu, 2001). The direction and degree of impact of adoption determinants are not uniform; the impact varies depending on type of technology and the conditions of areas where the technology is to be introduced (Legesse, 2001).

Practical experiences and observations of the reality have shown that, one factor may enhance adoption of one technology in one specific area for certain period of time while it may create hindrance for other locations (Tesfaye *et al*., 2001). Because of these reasons, it is difficult to develop a one and unified adoption model in technology adoption process for all specific locations. The conceptual framework presented in Figure-1 shows the most important variables expected to influence the participation of contract farming and adoption of improved farm technologies (IFTs) in the study area. The framework displays systematic relationship existing between our outcome decisions (both contract farming (CF) and adoption of IFTs) and the different set of farm household characteristics grouped under; demographic, institutional, endowment related variables and psychological factors. Household demographic factors include sex, age, household size, education, and experience, while socioeconomic factors are land tenure and farm size. Membership of FBOs, as well as access to credit and extension services are institutional or policy variables, while psychological factors include farmers' awareness of availability of IFTs, attitude towards risks as well as perception about interest rate. The household characteristics can lead to contract farming participation and adoption of IFTs. At the same time, CF participation can lead to the adoption of IFTs

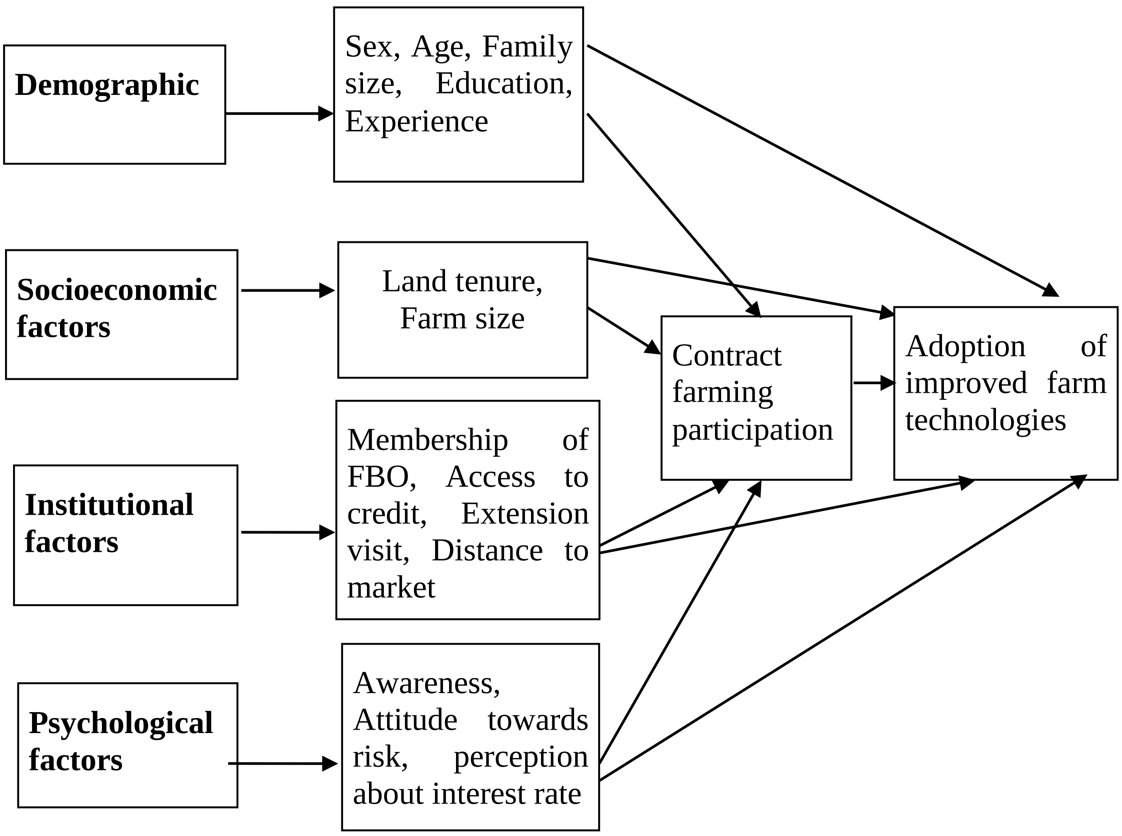

Figure 2.1: Conceptual framework of adoption of IFTs

Source: Adapted from Duvel (1990).

2.3 Theoretical Framework for Adoption of Improved Farm Technologies

There is an extensive literature aimed at explaining the process of new technology adoption (Skaggs, 2001; Foltz, 2003; Daberkow and Mcbride, 2003; Negri *et al*., 2005; Schuck *et al*., 2005; He *et al*., 2007; Donkoh and Awuni, 2011; Nkegbe *et al*., 2012). A farmer adopts a technology after analysing the net benefit to be achieved from the technology. If the expected returns from adopting a technology exceed the cost of its adoption, the farmer will go in for that technology and vice versa. Thus, farmers are assumed to maximize their utility function subject to some constraints (Asfaw *et al*, 2012). The difference between the utility from adopting improved farm technologies (U_{iA}) and the utility from not adopting the technology (U_{iN}) may be denoted as U_i^*, such that a utility maximizing farm household, i, will choose to adopt a new technology if the utility gained from adopting is greater than the utility from not adopting $(U_i^* = U_{iA} - U_{iN} > 0)$. Since these utilities are unobservable, they can be expressed as a function of observable elements in the latent variable model as shown in Equation 2.1.

By following Feleke and Zegeye (2006), Janvry *et al.*, (2010), Asfaw *et al*., (2012), and Kohansal and Firoozzare (2013), the adoption decision can be modeled in a random utility framework as follows:

$$U_i^* = X_i^{'}\gamma + U_i$$
$$with\ U_i = \begin{cases} 1\ if\ U_i^* > 0 \\ 0\ otherwise \end{cases} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2.1)}$$

where, U_i^* is the latent variable which represents the probability of the household's decision to adopt improved farm technologies, and takes the value '1' if the farmer adopts improved farm technologies, '0' otherwise. The term $X_i^{'}$ represents explanatory variables explaining the adoption decision, γ is a vector of parameters to be estimated, and u_i is the error term assumed to be independent and normally distributed as $u_i \sim N(0, 1)$. This is based on the assumption that farmers are rational.

In Foltz's framework, technology adopters will be those with a positive net willingness to pay for the technology. These are the farmers who have a reservation price, $P*(A, W, \eta)$, for the technology that is greater than or equal to the actual market price, P. Foltz (2003) defined the reservation price as the amount that an individual would be willing to pay for the technology given his asset position, A; other inputs he uses, W; and the parameters of his preference function, η. The price of the technology, P is the same for all individuals. Thus, for a given individual, the dependent variable Y is defined as an index variable for whether or not individuals adopt the new technology. It takes on the values of zero (0) and one (1) as follows:

$$\left.\begin{array}{l} Y = 1 \; if \;\; P^{*} \; (A, W, \eta) - P > 0 \\ Y = 0 \; if \;\; P^{*} \; (A, W, \eta) - P \leq 0 \end{array}\right\} \quad \text{....(2.2)}$$

Where the variables are as defined. Foltz stressed that, the function $P^{*}(A, W, \eta)$ is the shadow price for an individual adopting the technology, and P is the actual market price of the technology.

Foltz argued that the inference problem of econometrician then becomes a question of parameterising the equation that defines the net benefits of the technology to farmers. The standard model of preference choice in the literature is the random utility model. As a researcher, one is unable to observe the preference parameters of the utility function but, instead, to assume that they are known to decision makers.

Let these parameters be an unobserved variable so that actual utilities of an individual can be written as

$$U_i = P^*(A,W,\eta) - P = \beta' x + \varepsilon \quad \text{...}(2.3)$$

where x is a set of characteristics of the decision maker observable to the econometrician, and β is a parameter vector. Here $\beta' x$ becomes an index function that allows us to estimate the probability of adoption $Y = 1$ in the following fashion:

$$\Pr ob[P(A,W,\eta) - P > 0] = \Pr ob(\beta' x + \varepsilon > 0) \quad \text{.....................................}(2.4)$$

Assuming that the disturbance term is normally distributed, this becomes a standard probit model. By symmetry of the normal distribution, one gets:

$$\Pr ob(P^* - P > 0) = \Pr ob(\varepsilon < \beta' x) = F(\beta' x) \quad \text{.....................................}(2.5)$$

where $F(\cdot)$ is the cumulative density function of the normal distribution. This then is estimated using maximum likelihood estimation, in which the likelihood function is as follows:

$$\ln L = \sum_{y_i=0} \ln(1 - \Phi_i) + \sum_{y_i=1} \ln(\Phi_i) \quad \text{...}(2.6)$$

Note that the probit model is a discrete choice model which is applicable where one technology is involved. In the case of more than one technology, Poisson model or multivariate probit is ideal.

2.4 Adopter Categories

The criterion for adopter categorization is innovativeness. This is defined as the degree to which an individual is relatively early in adopting a new idea than other members of a social system. Innovativeness is considered "relative" in that an individual has either more or less of it than others in a social system (Rogers, 1971). Braak (2001), described innovativeness as “a relatively-stable, socially-constructed, innovation-dependent characteristic that indicates an individual's willingness to change his or her familiar practices".

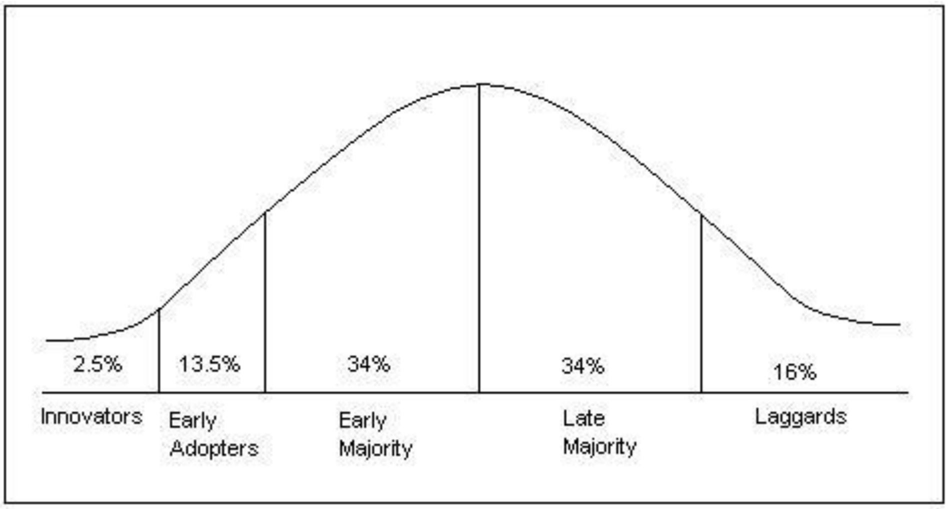

Figure 2.2: Adopter Categorisation on the Basis of Innovativeness

Source: Rogers, 1962.

Adopter distributions closely approach normality. The above figure shows the normal frequency distributions divided into five categories: innovators, early adopters, early majority, late majority and laggards. Innovators are the first 2.5 percent of a group to adopt a new idea. The next 13.5 percent to adopt an innovation are labeled early adopters. The next 34 percent of the adopters are called the early majority. The 34 percent of the group to the right of the mean are the late majority, and the last 16 percent are considered laggards (Rogers, 1971).

The above method of classifying adopters is not symmetrical or equal, nor is it necessary for it to be so. There are three categories to the left of the mean and only two to the right. While it is possible to break the laggard group into early and late laggards, research shows this single group to be fairly homogenous. While innovators and early adopters could be combined, research shows these two groups as having distinctly different characteristics. This method of adopter categorization is presently the most widely used in diffusion research (Rogers, 1971).

2.4.1 Innovators (Risk takers)

For Rogers (2003), innovators were willing to experience new ideas. Thus, they should be prepared to cope with unprofitable and unsuccessful innovations, and a certain level of uncertainty about the innovation. Also, Rogers added that innovators are the gatekeepers bringing the innovation in from outside of the system. They may not be respected by other members of the social system because of their fearlessness and close relationships outside the social system.

2.4.2 Early Adopters (Hedgers)

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" (Light, 1998). Thus, as role models, early adopters' attitudes toward innovations are more important. Their subjective evaluations about the innovation reach other members of the social system through the interpersonal networks. Early adopters' leadership in adopting the innovation decreases uncertainty about the innovation in the diffusion process. Finally, early adopters put their stamp of approval on a new idea by adopting it (Rogers, 2003).

2.4.3 Early Majority (Waiters)

Rogers (2003) claimed that although the early majority have good interaction with other members of the social system, they do not have the leadership role that early adopters have. However, their interpersonal networks are still important in the innovation-diffusion process. As Rogers stated, they are deliberate in adopting an innovation and they are neither the first nor the last to adopt it. Thus, their innovation decision usually takes more time than it takes innovators and early adopters.

2.4.4 Late Majority (Skeptics)

Similar to the early majority, the late majority includes one-third of all members of the social system who wait until most of their peers adopt the innovation. Although they doubt about the innovation and its outcomes, economic necessity and peer pressure may lead them to the adoption of the innovation. To reduce the uncertainty of the innovation, interpersonal networks of close peers should persuade the late majority to adopt it. Then, “the late majority feels that it is safe to adopt” (Rogers, 2003).

2.4.5 Late adopters or Laggards (Slowpokes)

As Rogers (2003) stated, laggards have the traditional view and they are more doubtful about innovations and change agents than the late majority. As the most localized group of the social system, their interpersonal networks mainly consist of other members of the social system from the same category. Moreover, they do not have a leadership role. Because of the limited resources and the lack of awareness-knowledge of innovations, they first want to make sure that an innovation works before they adopt. Thus, laggards tend to decide after looking at whether the innovation is successfully adopted by other members of the social system in the past. Due to all these characteristics, laggards’ innovation-decision period is relatively long.

2.5 Stages in Adoption Process

The classical 5-stage concept (awareness, interest, evaluation, trial, adoption) formulated by the North Central Rural Sociologists Committee has been the most widely accepted concept in explaining the stages of adoptions. It was initially exposed to a wider criticism by Campbell (1966) and later also by Rogers and Shoemaker (1971) who then designed the innovation decision process. According to Rogers (2003), adoption and diffusion studies focus on how farmers evaluate the new technologies and act on the evaluations which happen in several stages described below.

2.5.1 The Knowledge or Awareness Stage

At this stage, an individual learns about the existence of innovation and seeks information about the innovation. "What?", "how?" and "why?" are the critical questions in the knowledge phase. During this phase, the individual attempts to determine "what the innovation is and how and why it works" (Rogers, 2003). According to Rogers, the question forms three types of knowledge: (1) awareness-knowledge, (2) how-to-knowledge, and (3) principles-knowledge.

1) Awareness-knowledge: Awareness-knowledge represents the knowledge of the innovation's existence. This type of knowledge can motivate the individual to learn more about the innovation and, eventually, adopt it. Also, it may encourage an individual to learn about other two types of knowledge.

2) How-to-knowledge: The other type of knowledge, how-to-knowledge, contains information about how to use an innovation correctly. As Spotts (1999) stated, even the faculty who has technical backgrounds may not use technology in teaching, if they do not have knowledge of how to use it correctly. Thus, technology is not used at an expected level, since they need help in how to use the technology effectively in teaching (Spotts, 1999). Rogers saw this knowledge as an essential variable in the innovation-decision process. To increase the adoption chance of an innovation, an individual should have a sufficient level of how-to-knowledge prior to the trial of this innovation. Thus, this knowledge becomes more critical for relatively complex innovations.

3) Principles-knowledge:

The last knowledge type is principles-knowledge. This knowledge includes the functioning principles describing how and why an innovation works. An innovation can be adopted without this knowledge, but the misuse of the innovation may cause its discontinuance. For Sprague *et al*. (1999), the biggest barrier to faculty use of technology in teaching was that faculty lack a vision of why or how to integrate technology in the classroom.

To create new knowledge, technology education and practice should provide not only a how-to experience but also a know-why experience (Seemann, 2003). In fact, an individual may have all the necessary knowledge, but this does not mean that the individual will adopt the innovation because the individual's attitudes also shape the adoption or rejection of the innovation.

2.5.2 The Persuasion or Interest stage

At this stage, the individual becomes interested in the new idea and seeks additional information. Rogers (1995) have identified five characteristics of agricultural innovations which are important in adoption studies as the following.

i) Relative Advantage: Rogers (2003) defined relative advantage as the degree to which an innovation is perceived as better than the idea it supersedes. In other words, it is the superiority of the given technology in terms of perhaps yield, maturity period and pest or weed resistance than the one that preceded it.

ii) Compatibility: Rogers (2003) stated that "compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters".

iii) Complexity: Rogers (2003) defined complexity as "the degree to which an innovation is perceived as relatively difficult to understand and use".

iv) Trialability: The degree to which the innovation could easily be tried by farmer on his/her farm as most farmers have seen to be better convinced only when they have physically exposed to the innovation that they want to apply.

v) Observability: The degree to which results of innovation are visible to farmers in terms of the special attributes related with the innovation as compared to the conventional ones (better yield, resistance to pest and disease and quality).

2.5.3 The Decision or Evaluation 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 to adopt an innovation" (Rogers, 2003). If an innovation has a partial trial basis, it is usually adopted more quickly, since most individuals first want to try the innovation in their own situation and then come to an adoption decision. The eventual trial can speed up the innovation-decision process. However, rejection is possible in every stage of the innovation-decision process. Rogers expressed two types of rejection: active rejection and passive rejection.

i) In an active rejection situation, an individual tries an innovation and thinks about adopting it, but later he or she decides not to adopt it. A discontinuance decision, which is to reject an innovation after adopting it earlier, may be considered as an active type of rejection.

ii) In a passive rejection (or non-adoption) situation, the individual does not think about adopting the innovation at all.

Rogers stated that these two types of rejection have not been distinguished and studied enough in past diffusion research. In some cases, the order of the knowledge-persuasion-decision stages can be knowledge-decision-persuasion. Especially in collectivistic cultures such as those in Eastern countries, this order takes place and group influence on adoption of an innovation can transform the personal innovation decision into a collective innovation decision (Rogers, 2003). In any case, however, the implementation stage follows the decision stage.

2.5.4 The Implementation or Trial Stage

At the implementation stage, an innovation is put into practice. However, an innovation brings the newness in which "some degree of uncertainty is involved in diffusion". Uncertainty about the outcomes of the innovation still can be a problem at this stage. Thus, the implementer may need technical assistance from change agents and others to reduce the degree of uncertainty about the consequences (Rogers, 2003).

Reinvention usually happens at the implementation stage, so it is an important part of this stage. Reinvention is "the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation" (Rogers, 2003). Also, Rogers (2003) explained the difference between invention and innovation. While "invention is the process by which a new idea is discovered or created," innovation is the process of using an existing idea" (Rogers, 2003).

2.5.5 The Confirmation or Adoption Stage

Once the processes of integration and re-invention are completed, the final stage, Confirmation Stage, has been reached. At this point, the person finalizes their decision regarding the adoption of the technology. Here, two options are available; 1) adoption of the technology: At this point, the person is committed to using the technology to its fullest potential it can serve in his/her life. 2) reversal of the original choice to use the technology: This is essentially a delayed rejection. According to Rogers (2003), the decision to reverse in the use of the technology is possible if the individual is "exposed to conflicting messages about the technology or innovation". However, the individual tends to stay away from these messages and seeks 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.

Discontinuance may occur during this stage in two ways. First, the individual rejects the innovation to adopt a better innovation replacing it. This type of discontinuance decision is called replacement discontinuance. The other type of discontinuance decision is disenchantment discontinuance. In the latter, the individual rejects the innovation because he or she is not satisfied with its performance. Another reason for this type of discontinuance decision may be that the innovation does not meet the needs of the individual.

2.6 Empirical Literature review on Farm Technology Adoption Decision

Literature on adoption of improved farm technologies indicate that the adoption decision of farmers is influenced by a number of variables such as demographic, socioeconomic, institutional and psychological factors.

2.6.1 Farmers' Socio-demography Characteristics

According to Doss et al. (2003), numerous studies of technologies adoption in developing countries have used farmers' socio-demographic characteristics (e.g., household heads' gender, age, education, household size) to explain household adoption behaviors. A few of these studies reported that the rate of technology adoption is higher among male-headed households, compared to female-headed households because of discrimination (i.e., women have less access to external inputs, services, and information due to socio-cultural values).

Adesina and Forson (1995), who studied farmers' adoption of new agricultural technology in Burkina Faso and Guinea, reported that both young and old sorghum farmers in Burkina Faso adopt new technology. Young farmers adopted the technology because they have long term plans and are willing to take risks. On the other hand, old farmers adopted it because they have accumulated capital or have greater access to credit, due to their age. However, older farmers have the higher probability of adoption of technologies. The effect of farming experience (measured by the age of the household head) is not always positively associated with farmers' adoption behaviours. For example, Zavale *et al.*, (2005) reported that older farmers in Mozambique are less likely to adopt improved maize variety than younger farmers.

Feder *et al.*, (1985), provided empirical evidence on the importance of human capital (e.g., farmer's education) on technology adoption. They argued that education enhances the ability of farmers to acquire, synthesize, and quickly respond to disequilibria, thereby increasing their likelihood of adoption of new agricultural technologies. According Adegbola and Gardebroek (2007), educated farmers are able to better process information, allocate inputs more efficiently, and more accurately assess the profitability of new technology, compared to farmers with no education. Zavale *et al.*, (2005) and

Uaiene *et al.*, (2009) report that the level of education attained by households in Mozambique is positively associated with households' adoption behaviors. The authors suggested that education positively influences households to quickly respond to their current low agricultural productivity by adopting new agricultural technologies that increase productivity, household income and its standard of living. However they also reported that most household heads in Mozambique are illiterate and had attended school for only a few years.

According to Feder *et al.*, (1985), some new agricultural technologies, including improved varieties, are more labour intensive, compared to traditional varieties. Thus, labour shortage may prevent farmers from adopting new agricultural technology. The authors argued that a household with a large number of family members who are available to work on the farm are more likely to adopt new technologies than household with a small number of family members.

2.6.2 Endowment related variables

Among the proxy for wealth measurement factors that has a positive and significant correlation is the size of household land holding. The size of farmland owned by the household is associated with the decision to use improved farm technologies, since land is the scarcest production resource in this part of the country (Brush *et al.*, 1990).

According to Feder *et al.*, (1985), the coefficient of household land size has a significantly positive correlation with adoption decision due to the fact that it is a surrogate for a large number of factors such as size of wealth, access to credit, capacity to bear risk, access to information and other factors. The study conducted by CIMMYT (1993) in Tanzania dictates that land size has a positive relationship with adoption of improved technology. In addition, a study by Sain and Martinez, (1999) indicates that an increase of 10 percent in the total farm area results in an increase of approximately 12.5 percent in the probability of sowing part of the maize acreage with hybrid maize. This figure is also consistent with those found in other studies on adoption of new technologies (Brush *et al.,* 1990). On contrary, similar studies by the same institution CIMMYT (1993) in Ethiopia showed that land size has no significant correlation with adoption decision rather with the amount of fertilizers purchased.

2.6.3 Institutional Factors

Institutional factors (e.g., having access to extension services, credit, being a member of an agricultural association etc.) have been widely used to assess farmers' adoption behavior. Pattanayak et al. (2003) argued that access to extension services provided by the government, NGOs, and other stakeholders played a very important role in the adoption of new agricultural technologies. Farmers who were exposed to information about new technologies by extension agents (through training, group discussion, plots demonstration, and other form of information delivery) tend to adopt new technologies. An empirical study by Boughton *et al.*, (1993) suggested that in Mali, the farm-level adoption rates for improved maize varieties could be significantly increased by an extension programme that tailors varietals promotion to individual farmers' needs and circumstances.

Capital constraints and limited access to credits hinder the adoption of agricultural technologies. These factors especially apply to new inputs or technologies that require a high initial capital investment and high operational costs (Feder *et al*. 1985). However, a few empirical studies reported, that some new technologies that do not require a high initial capital investment (e.g., improved varieties, maize-legume rotation) also have low adoption rates because farmers do not have sufficient capital and access to credits. For example, Uaiene *et al.* (2009) and Zavale *et al*. (2005), who analyzed agricultural technologies adoption in Mozambique, using TIA 2002 and 2005 data, reported that difficulty in accessing credit appears to be one of the major constraints to adoption.

Bandiera and Rasul (2005), who analyzed social networks and technology adoption in Northern Mozambique, reported that the likelihood of adopting new technologies was high among farmers who have access to paved road, markets, and farmer associations because they were more likely to be exposed to information about the potential benefits of new technologies, contact with extension agents, as a result of market exposure, and from interactions with other association members.

2.6.4 Psychological factors

There are a number of studies on the psychological aspects of the technology transfer and adoption (Duvel and Botha, 1999; Habtemariam, 2004; Ebrahim, 2006; Mekonnen, 2007). Perceptions of the characteristics of new agricultural technology are important factors that are associated with farmers' demand for new agricultural technologies (Adesina and Forson, 1995). Farmers may subjectively evaluate the technical and cultural aspects of technologies differently. Thus, understanding farmers' perceptions is important in designing and promoting agricultural technologies (Uiene *et al.*, 2009). In general, farmers' perceptions of the characteristics of new agricultural technologies are divided into three main categories: yield performance, cost requirements, and risks.

Feder *et al.* (1985) argue that yield performance (or expected yield of new varieties) is one of the characteristics of improved varieties that affect farmers' technological adoption behaviors. Several empirical studies show that the adoption rate of improved varieties is high, if the varieties meet farmers' expectations. An improved variety will be adopted at exceptionally high rates, if the new variety is technically and economically superior to local varieties. Improved varieties are technically superior if they produce higher yield than traditional varieties. For example, Adesina and Forson (1995) report that farmers in Burkina Faso adopted a modern sorghum variety because it gave high yield, compared to the traditional sorghum variety that farmers planted in previous agricultural years.

Neill and Lee (2001) argue that farmers' adoption of new agricultural technologies is also affected by farmers' perception of the amount of initial capital investment and labor requirements they will have to allocate if they adopt the underlying technology. Martel et al. (2000), who conducted a case study of the marketing of dry beans in Honduras, argue that farmers adopt new agricultural technologies because they perceive that a new technology could reduce labor requirements and other associated costs, and reduce losses due to risk (i.e., crop diseases) during production and/or post harvesting. Furthermore, they argue that bean farmers always compare the new bean variety to their current variety. Farmers are more likely to adopt a new bean variety if it performs well under different environmental conditions, shows economic profitability, and is resistant or tolerant to disease and insects.

Adegbola and Gardebroek (2007), who analyzed the effect of information sources on technology adoption and modification in Benin, report that in addition to considering yields, direct costs, and profits associated with improved maize seeds, farmers also consider seed characteristics that reduce risks, because damages from insects and/or disease during maize production and storage can result in substantial yield losses and poor grain quality. In some circumstances, these losses not only increase the risk of food insecurity for the farmers' households, but may also decrease farmers' income -- if the losses in quantity are not sufficiently compensated for by a price increased due to deficit in national supply. With respect to risks, several other studies report that farmers also consider environmental aspects, such as whether or not the improved varieties were developed for local climate and soil fertility conditions (Doss, 2003), or for variations in local agro-ecological patterns (Doss, 2003).

2.7 Definitions of Contract Farming

Different terms have been used to refer to contract farming. Some of the terms include core-satellite farming, nucleus estate and out-grower schemes. The terms are used interchangeably; however, some writers have tried to differentiate between them. For example, Glover (1984) differentiated between contract farming and out-grower schemes. He explained contract farming as a term used to identify schemes operated by private companies (both local and foreign) and out-grower schemes as those operated by parastatal organizations. The literature contains numerous definitions of contract farming. Some of the definitions include:

Contract farming refers to a system where a central processing or exporting unit purchases the harvests of independent farmers and the terms of the purchase are arranged in advance through contracts (Baumann, 2000).

The Contract Farming Resource Centre (CFRC) defines contract farming (CF) as agricultural production carried out according to an agreement between a buyer and farmers, which establishes conditions for the production and marketing of farm products (CFRC, 2008).

According to Singh (2005), contract farming can be defined as a system for the production and supply of agriculture and horticultural produce by farmers or primary producers under advance contracts, the essence of such arrangements being a commitment to provide an agricultural commodity of a type, at a specified time, price, and in specified quantity to a known buyer.

Prowse (2012) described contract farming as a form of vertical integration within agricultural commodity chains that provides the firm with greater control over the production process as well as quantity, quality, characteristics and the timing of what is produced.

"A binding arrangement between a firm (contractor) and an individual producer (contractee) in the form of a 'forward agreement' with well-defined obligations and remuneration for tasks done, often with specifications on product properties such as volume, quality, and timing of delivery" (Catelo and Costales, 2008);

"Contract farming can be defined as an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices" (Eaton and Shepherd, 2001).

"An intermediate mode of coordination, whereby the conditions of exchange are specifically set among transaction partners by some form of legally enforceable, binding agreement. The specifications can be more or less detailed, covering provisions regarding production technology, price discovery, risk-sharing and other product and transaction attributes"(Da Silva, 2005);

"Agricultural production carried out according to a prior agreement in which the farmer commits to producing a given product in a given manner and the buyer commits to purchasing it" (Minot, 2007);

"A contractual arrangement between farmers and other firms, whether oral or written, specifying one or more conditions of production, and one or more conditions of marketing, for an agricultural product, which is non-transferable" (Rehber, 2007).

2.8 Types of Agricultural Contracts

Glover and Kusterer, (1990) suggested that contracts can be thought of as varying in 'intensity'. According to them, it is the nature and content of a contract that matters. Accordingly three classification of contract farming could include the following:

The first is market-specification contracts, which guarantee a farmer a marketing outlet and time of sale, and possibly a price structure, if some degree of quality is met. Minot (2007) outlines how market-specification contracts reduce co-ordination costs, particularly for perishable products or those with complex quality attributes, through addressing marketing information asymmetries. Clearly, farmers retain full control over production.

The second is resource-providing contracts, where certain physical or technical inputs are provided by a firm, with the requirement that produce is marketed through that same firm. This reduces the farmers' cost of choosing, accessing and purchasing inputs, and the firm is assured quality of produce and (usually) repayment. Resource providing contracts are often used for crops that require specific inputs or quality standards and in circumstances when farmers struggle with imperfect input markets.

The third type is production-management contracts, where the firm stipulates and enforces conditions of production and farm-based processing. Farmers thus relinquish a degree of control over the production process on the farm. The costs to the firm for ensuring compliance are recouped from the sale of higher-quality produce.

2.9 Models of Contract Farming:

Contract farming has its various types based on the model being adopted. According to Mansur et al. (2009) models of contract farming include the centralised model, nucleus estate model, multipartite model, informal model and intermediary model.

The Centralised Model: According to Mansur et al. (2009), it is a vertical coordination where the sponsor purchases the crop from farmers and processes and markets the products. Except in a limited number of cases, farmer quotas are normally distributed at the beginning of each growing season and quality is tightly controlled (Eaton and Shepherd, 2001). The centralized scheme is generally associated with tobacco, cotton, sugar cane and bananas and with tree crops such as coffee, tea, cocoa and rubber, but can also be used for poultry, pork and dairy production. Where fresh vegetables and fruits are grown under contract, the term “processing” may include grading, sorting and packaging as well as the provision of cool storage facilities.

The Nucleus Estate Model: This is a variation of the centralized model. In this case the sponsor of the project also owns and manages an estate plantation, which is usually close to the processing plant (Mansur et al., 2009). The estate is often fairly large in order to provide some guarantee of throughput for the plant, but on occasion it can be relatively small, primarily serving as a trial and demonstration farm. A common approach is for the sponsors to commence with a pilot estate then, after a trial period, introduce to farmers (sometimes called “satellite” growers) the technology and management techniques of the particular crop. Even though nucleus estate is mainly used for tree crops, there are examples of the nucleus estate concept with other products, for example, the operation of dairy nucleus estates, with the central estate being primarily used for the rearing of “parent stock”.

The Multipartite Model: According to Mansur *et al.* (2009), this model includes many types of agencies, intermediary model where middlemen are involved between the company and the farmer. Multipartite contract farming may have separate organizations responsible for credit provision, production, management, and processing and marketing.

The Informal Model: According to Mansur *et al.* (2009), this model applies to individual entrepreneurs or small companies who normally make simple, informal production contracts with farmers on a seasonal basis, particularly for crops such as fresh vegetables, watermelons and tropical fruits. Crops usually require only a minimal amount of processing. Material inputs are often restricted to the provision of seeds and basic fertilizers, with technical advice limited to grading and quality control matters. A common example of the informal model is where the sponsor, after purchasing the crop, simply grades and packages it for resale to the retail trade.

The Intermediary Model: According to Mansur *et al.* (2009), in this model, middlemen are involved between the company and the farmer. Usually the agrifood company buys the produce from an intermediary organisation, such as farmer committees, who in their turn have a separate agreement for buying supply from the farmers. The use of intermediaries must always be approached with caution because of the danger of sponsors losing control over production and over prices paid to farmers by middlemen..

2.10 Empirical studies of Contract Farming Arrangements (CFAs)

Early empirical research on contact farming was mostly qualitative, based on case studies informed by primary data taken from in-depth interviews with key informants and/or secondary data taken from reports and company documents (for example, Glover (1984, 1987, 1990); Glover and Kusterer (1990); and Goldsmith (1985)). These studies adopted a broad socio-economic approach in assessing the impact of contract farming

(CF) and concluded that CFAs increased the incomes of smallholders, their access to credit and technical support, their production and productivity, helped to introduce new technologies and created jobs and additional income in the local economy. CF also was credited with establishing farmers' associations, drawing women into the production economy, and providing households with opportunities to improve their nutritional and health status. Glover and Kusterer (1990) emphasised the transferability of improved technical, managerial and negotiation skills, and a better understanding of costs, quality and markets to other enterprises.

In the early case studies of CF by Glover (1984, 1987, and 1990), Glover and Kusterer (1990), Goldsmith (1985) and Simmons (2002), they found no clear evidence of bias against resource poorer farmers despite expectations that smaller farmers would be higher cost suppliers. Glover and Kusterer (1990) attributed this lack of bias to superior product quality on the part of smaller farmers, a tendency for larger farmers to find their own markets as they gained experience and wealth, and the social responsibility agenda that motivated agribusiness firms to engage in CFAs. Apart from informing the debate over the merits of CF, these early qualitative studies helped to refine the theoretical propositions and research questions subsequently addressed in numerous quantitative studies.

Bellemare (2012) study in Madagascar found that CF had a significant positive impact on total household income, net household income, income net of contract farming, income per adult equivalent and household income from livestock. Bolwig *et al*., (2009) also found that a CFA with certified organic coffee farmers in Uganda increased gross revenue and net profit from coffee.

Narayanan (2014) compared the CF profits of four commodities with profits from alternative markets using cross-sectional survey data in India's Punjab state. She found variable impacts of CF not only across schemes (with different crops and firms) but also between farmers within a particular scheme. Miyata *et al.,* (2009) argued that profit from the contracted crop would tend to overstate the impact of CFA on household wellbeing as the CFA might draw labour and other resources from the household's other income generating enterprises. Instead, they used total household income per capita as their indicator of impact and found that CFAs with green onion and apple growers in China had positive impacts on per capita household income.

However, a study in India by Singh (2002) suggested that the positive early impact of CF on households and the local economy (through higher farm employment) could be short-lived due to unsustainable promotional prices and subsidies from firms, and the erosion of benefits when perceived power imbalances discouraged continued participation.

Michelson *et al.,* (2012) studied CFAs between supermarkets and vegetable and fruit growers in Nicaragua using historical data spanning eight years and concluded that the CFAs did not benefit small farmers. They found that farmers contracted by domestic supermarkets were receiving the same mean prices paid by traditional markets. While international supermarkets provided insurance against volatile prices, farmers were paid disproportionately low mean prices. However, the same CFAs were credited with increasing annual household income and investment in productive assets compared to non-participants in the area (Michelson, 2013). No evidence of positive impact was found on investment in consumer durables or on the land holdings of participating farmers.

Masakure and Henson (2005) identified four groups of incentives or benefits of CFAs as perceived by contract farmers in Zimbabwe's high value vegetable export sector. The first group, labelled 'market certainty' included guaranteed markets, minimum prices and the provision of inputs and transport. The second group, labelled 'indirect benefits', included skills that could be applied to other crops and the use of CFAs as a stepping stone to other projects. The third group related to higher incomes, and the fourth to intangible benefits such as prestige.

Higher incomes and related benefits from participation in CFAs have been attributed to higher yields from greater use of specialised inputs and technical support, higher quality products and better access to premium markets (Bolwig *et al.*, 2009; Miyata *et al.*, 2009).

Savings from low transaction costs arising from guaranteed input and output markets, clearer quality criteria, and transparent measurements of volume and quality were also identified as a source of these benefits (Bolwig *et al.*, 2009; Narayanan, 2014)

Most studies on the impact of CF on participant households provided complementary information on factors affecting participation. In western Kenya, it was found that the average size of farms contracted to supply a large sugar company had decreased over time (Casaburi *et al.*, 2014). This suggested that farmers with relatively smaller farms were able to join and were not forced out of the CFA once its processes had been honed.

In China, Miyata *et al.* (2009) found that participation in a number of apple and onion CFAs was influenced by labour availability, distance from village heads and possession of agricultural equipment. Resource endowments and agriculture's share of household income were important determinants of participation in Uganda's SIPI certified organic coffee CFA (Bolwig *et al.*, 2009). In India, participation in vegetable contracts was found to be biased in favour of larger farmers and farmers that achieved higher yields (Narayanan, 2014; Singh, 2002).

According to Bellamare, (2012), Gender, age, agricultural experience, participation in cooperatives, land endowments, working capital, number of days that farmers do not work for cultural reasons, level of entrepreneurial/business skills, and attitude towards risk were significant determinants of participation in Madagascar CFAs. On the inclusiveness of CFAs, Barrett *et al.*, (2012) commented that very few farmer, household or farm characteristics have been found to consistently affect participation in CFAs.

2.11 Advantages of contract farming (CF) to farmers

The prime advantage of a contractual agreement for farmers is that the sponsor will normally undertake to purchase all produce grown, within specified quality and quantity parameters. Contracts can also provide farmers with access to a wide range of managerial, technical and extension services that otherwise may be unobtainable. Farmers can use the contract agreement as collateral to arrange credit with a commercial bank in order to fund inputs. Thus, the main potential advantages for farmers are:

Provision of inputs and production services

Many contractual arrangements involve considerable production support in addition to the supply of basic inputs such as seed and fertilizer. Sponsors may also provide land preparation, field cultivation and harvesting as well as free training and extension. This is primarily to ensure that proper crop husbandry practices are followed in order to achieve projected yields and required qualities. There is, however, a danger that such arrangements may lead to the farmer being little more than a labourer on his or her own land (Eaton and Shepherd, 2001).

Access to credit

The majority of smallholder producers experience difficulties in obtaining credit for production inputs. With the collapse or restructuring of many agricultural development banks and the closure of many export crop marketing boards, particularly in Africa, which in the past supplied farmers with inputs on credit, difficulties have increased rather than decreased. Contract farming usually allows farmers access to some form of credit to finance production inputs. In most cases it is the sponsors who advance credit through their managers. However, arrangements can be made with commercial banks or government agencies through crop liens that are guaranteed by the sponsor, i.e. the contract serves as collateral. When substantial investments are required of farmers, such as packing or grading sheds, tobacco barns or heavy machinery, banks will not normally advance credit without guarantees from the sponsor (Eaton and Shepherd, 2001).

Introduction of appropriate technology

According to Eaton and Shepherd (2001), new techniques are often required to upgrade agricultural commodities for markets that demand high quality standards. New production techniques are often necessary to increase productivity as well as to ensure that the commodity meets market demands. However, small-scale farmers are frequently reluctant to adopt new technologies because of the possible risks and costs involved. They are more likely to accept new practices when they can rely on external resources for material and technological inputs. Nevertheless, the introduction of new technology will not be successful unless it is initiated within a well managed and structured farming operation. Private agribusiness will usually offer technology more diligently than government agricultural extension services because it has a direct economic interest in improving farmers' production.

Skill transfer

According to Eaton and Shepherd (2001), the skills the farmer learns through contract farming may include record keeping, the efficient use of farm resources, improved methods of applying chemicals and fertilizers, knowledge of the importance of quality and the characteristics and demands of export markets. Farmers can gain experience in carrying out field activities following a strict timetable imposed by the extension service. In addition, spillover effects from contract farming activities could lead to investment in market infrastructure and human capital, thus improving the productivity of other farm activities. Farmers often apply techniques introduced by management (ridging, fertilizing, transplanting, pest control, etc.) to other cash and subsistence crops.

Guaranteed and fixed pricing structures

The returns farmers receive for their crops on the open market depend on the prevailing market prices as well as on their ability to negotiate with buyers. This can create considerable uncertainty which, to a certain extent, contract farming can overcome. Frequently, sponsors indicate in advance the price(s) to be paid and these are specified in the agreement. On the other hand, some contracts are not based on fixed prices but are related to the market prices at the time of delivery. In these instances, the contracted farmer is clearly dependent on market volatility (Eaton and Shepherd 2001).

Access to reliable markets

Small-scale farmers are often constrained in what they can produce by limited marketing opportunities, which often makes diversification into new crops very difficult. Farmers will not cultivate unless they know they can sell their crop, and traders or processors will not invest in ventures unless they are assured that the required commodities can be consistently produced. Contract farming offers a potential solution to this situation by providing market guarantees to the farmers and assuring supply to the purchasers (Eaton and Shepherd, 2001).

2.12 Problems of Contract Farming (CF) to Farmers

For farmers, the potential problems associated with contract farming include; Increased risk, unsuitable technology and crop incompatibility, manipulation of quotas and quality specification, corruption, domination by monopolies, and indebtedness and overreliance on advance.

Increased risk

Eaton and Shepherd (2001) however, cautioned that, farmers entering new contract farming ventures should be prepared to balance the prospect of higher returns with the possibility of greater risk. Such risk is more likely when the agribusiness venture is introducing a new crop to the area. There may be production risks, particularly where prior field tests are inadequate, resulting in lower-than-expected yields for the farmers. Market risks may occur when the company's forecasts of market size or price levels are not accurate. Considerable problems can result if farmers perceive that the company is unwilling to share any of the risk, even if partly responsible for the losses.

Unsuitable technology and crop incompatibility

The introduction of a new crop to be grown under conditions rigorously controlled by the sponsor can cause disruption to the existing farming system. For example, the managers may identify land traditionally reserved for food crops as the most suitable for the contracted crop. Harvesting of the contracted crop may fall at the same time as the harvesting of food crops, thus causing competition for scarce labour resources. Particular problems may be experienced when contract farming is related to resettlement programmes. In Papua New Guinea, for example, people from the Highlands were resettled in coastal areas to grow oil palm and rubber. This required the farmers, who were traditionally sweet potato eaters, to learn cultivation techniques for new food crops and to adapt their dietary practices accordingly (Eaton and Shepherd, 2001).

Manipulation of quotas and quality specifications

Eaton and Shepherd (2001) also noted that, inefficient management can lead to production exceeding original targets. For example, failures of field staff to measure fields following transplanting can result in gross overplanting. Sponsors may have unrealistic expectations of the market for their product or the market may collapse unexpectedly owing to transport problems, civil unrest, change in government policy or the arrival of a competitor. Such occurrences can lead managers to reduce farmers' quotas. In some situations management may be tempted to manipulate quality standards in order to reduce purchases while appearing to honour the contract. Such practices will cause sponsor-farmer confrontation, especially if farmers have no method to dispute grading irregularities. All contract farming ventures should have forums where farmers can raise concerns and grievances relating to such issues.

Corruption

As described by Eaton and Shepherd (2001), problems occur when staff responsible for issuing contracts and buying crops, exploit their position. Such practices result in a collapse of trust and communication between the contracted parties and soon undermine any contract. Management needs to ensure that corruption in any form does not occur. On a larger scale, the sponsors can themselves be dishonest or corrupt.

Domination by monopolies

The monopoly of a single crop by a sponsor can have a negative effect. Allowing only one purchaser encourages monopolistic tendencies, particularly where farmers are locked into a fairly sizeable investment, such as with tree crops, and cannot easily change to other crops. On the other hand, large-scale investments, such as for nucleus estates, often require a monopoly in order to be viable. In order to protect farmers when there is only a single buyer for one commodity, the government should have some role in determining the prices paid (Eaton and Shepherd, 2001).

Indebtedness and overreliance on advances

As stated by Eaton and Shepherd (2001), one of the major attractions of contract farming for farmers is the availability of credit provided either directly by the company or through a third party. However, farmers can face considerable indebtedness if they are confronted with production problems, if the company provides poor technical advice, if there are significant changes in market conditions, or if the company fails to honour the contract. This is of particular concern with long-term investments, either for tree crops or for on-farm processing facilities. If advances are uncontrolled, the indebtedness of farmers can increase to uneconomic levels.

2.13 Contract Farming and Technology

The industrialisation of agriculture has resulted in significant and widespread institutional, technological and social changes to agricultural production at a global level. These changes are largely the result of advances in biological and information technologies, along with general economic growth, the increasing scale of organisation and the relative modernisation of production, processing and distribution systems (Schrader,1986). Technologies allow processors to produce customised products to meet the changing lifestyle and food safety concerns of the consumer. The harnessing of technology ensures that the consumer gets the quality, consistency, value and other product characteristics they demand (Drabenstott, 1995). The resultant increased levels of technology utilised in the manufacture and processing of agricultural commodities has resulted in the expansion of product uses and in the development of additional products (Braun *et al.*, 1994).

The rise of contract farming systems are quickly replacing spot markets for domestic agricultural crops, export agricultural crops and other agricultural products, and has heralded an increase in product quality and safety along with the use of more consistent technology (Vellema, 2002). Production contracts are increasingly linking small, medium and large-scale farmers in developing countries more directly to consumers in both domestic and foreign markets. These linkages are made possible by the increased vertical coordination of agricultural firms or retail distributors, as represented by both transnational corporations and indigenous bodies - national corporations - that cater for the changing demands of society (Kirsten and Sartorius, 2002). At the heart of these changes are the technological advances and processes that allow for the increased industrialisation of the agricultural sector. Nevertheless, Kirsten and Sartorius cautioned, “although this sounds like an ideal situation, traditional markets do not handle these circumstances well.” Indeed, changes in agricultural systems throughout the world are resulting in social, cultural and economic impacts. There is considerable debate on the positive and negative impacts of technology transfer by agribusiness to the developing world. In this regard, some researchers have questioned the appropriateness of technology transfer by multinational corporations to developing economies, citing unspecified adverse effects on the social and political environment (Dicken, 1986).

Notwithstanding these concerns, the use of contract farming systems is rapidly increasing in developing countries (Oya, 2012). The global sourcing of agricultural products in the developing world is resulting in the rapid replacement of more traditional forms of agriculture, along with the social interrelationships that supported them. Efficient agricultural production requires contracted farmers to have timely crop cultivation techniques, and considerations such as how and when to fertilise, weed, water, and apply pesticides and fungicides are crucial to this process. It also requires that outgrowers have information on the product requirements of the processor, such as export standards related to chemical use (Key and Runsten, 1999). This is of particular importance since the cultivation regime varies considerably in accordance with the technological requirements of the specific crop.

The contracted crop is frequently an important determinant of the socioeconomic characteristics of the outgrower sought by processors (Glover, 1987). Larger farmers have a distinct advantage over smaller farmers if processors rely on the contracted farmers to acquire technological and production information on their own. This is because larger producers are frequently better educated and can spread the fixed costs of acquiring knowledge over a broader revenue base. In the case of labour-intensive crops, such as oil palm, the small farmer has an advantage in that he/she can access labour from the extended family structure. The processor, however, must ensure that they mount an effective extension program to transfer both the optimal cultivation techniques to their small-scale outgrowers and to ensure that the contracted farmers are fully aware of their product requirements. As Poulton et al. observed, “efficiency of input use and farmers’ demand for inputs can be encouraged by the strengthening of technical knowledge and their use” (Poulton *et al.*, 2010). None of this negates the frequently reported rationale of farmers in developing countries that they enter into production contracts to gain access to technology, technical skills and managerial processes. To realise these benefits, farmers are prepared to surrender some of their independence in order to acquire new facets of production (Clapp, 1994). Through the application of new technology and the use of modern managerial systems, outgrowers can increase production, reduce costs and augment their incomes (Clapp, 1988).

While contract farming schemes are increasingly being developed within the context of an agro-industrial environment characterised by increasing vertical coordination, the attempt to control production through the introduction of new technology rarely involves a standardisation of social relations in production. This is important because it affirms that there is no established 'outgrower technology' program that can be universally applied. As Vellema indicated, "… the institutional and organizational configurations of contract farming are extremely varied. There are many ways in which companies organize production, both technically and socially."

The economic liberalisation and institutional reform that has taken place in the agricultural sector has occurred alongside a decline in the role of government in the provision of agricultural services and the dissemination of agricultural research via their extension services. Within this new economic order, the private sector has to assume the responsibility for the provision of agricultural research, extension, production and marketing services via outgrower contracts (Coulter *et al.*, 1999). As a direct result, the institutional absorption and integration of farmers into new production systems has taken place. Watts argued that contract farming leads to the "deskilling of labour" (Watts, 1994)

While agreeing that this could be the case in highly regulated schemes, Grossman indicated that it is by no means a certainty, postulating that "… in many cases, peasants modify technical packages to suit local needs…." (Grossman, 1995)

The success of liberalisation and institutional reform in the agricultural sector is contingent upon the willingness of the farmers to learn new technologies (Benziger, 1996). While recognising some of contract farming's negative features, Glover nevertheless pointed out that, "… one of contract farming's most promising features is its effectiveness in transferring technology to small farmers. To exclude small farmers from contract farming involving technologically dynamic crops is to exclude them from one of their few opportunities for exposure to new techniques" (Glover, 1987). Glover and Kusterer also observed that improvements to the farming and management skills of small farmers are possible over relatively short periods (Glover and Kusterer, 1990).

2.14 Effect of contract farming on the adoption of improve technologies

Contract farming has won approval for its developmental potential because it is a way to transfer technology to small-scale farmers. Since the contractor will have a direct interest in improving the quality of the produce, the theory is that it will provide more and better technical assistance than the public extension service. Ellman (1997) found that CDC projects had been successful as a means of transferring technology. Furthermore, because CDC has concentrated on limited crops, they have developed some expertise and new farmers do not need to be treated as test cases for new technology. Glover and Kusterer (1990) reported that rapid technology transfer is most likely to occur when a new crop has been introduced for which quality standards are very important.

The South Nyanza Sugar Company (SONY) in Kenya placed a strong emphasis on field extension services to its 1,800 contracted farmers, at a ratio of one field officer to 65 sugar-cane growers. The extension staff's prime responsibilities were focused on the managerial skills required when new techniques are introduced to SONY farmers. These include transplanting, spacing, fertilizer application, cultivation and harvesting practices. Also, SONY promotes farmer training programmes and organizes field days to demonstrate the latest sugarcane production methods to farmers.

Hindustan Lever issued contracts to 400 farmers in northern India to grow selected varieties of tomatoes for paste. A study of the project confirmed that production yields and farmers' incomes increased as a result of the use of hybrid seeds and the availability of an assured market. An analysis of the yields and incomes of the contracted farmers compared with farmers who grew tomatoes for the open market showed that yields of the farmers under contract were 64 percent higher than those outside the project.

According Eaton and Shepherd (2001), farmers adopted improved methods of applying chemicals and fertilizers through their involvement in contract farming. Other skills the farmers learned through contract farming included record keeping and efficient use of farm resources.

According to McMichael (2013), introduction of new technology will not be successful unless it is initiated within a well managed and structured farming operation. Contractors usually offer technology more diligently than government agricultural extension services because it has a direct economic interest in improving farmers' production. Most of the larger sponsors prefer to provide their own extension rather than rely on government services (Da Silva, 2005).

Through contract farming, smallholder farmers adopted row planting in maize in Kenya as a way of increasing their productivity and also to enable them produce according to the quality standards that contracts prescribe. The technological assistance provided through contract farming can take the form of seeds, fertilizers, pesticides, farm equipment and skill transfer, among others (Patel 2013).

The use of the new technologies and inputs often depend on already existing resources, such as size of land holdings and facility of access to credit and extension services (Patel 2013). As a result, agricultural companies are often inclined to work with farmers who already have a certain amount of resources at their disposal. In addition, the provision of specific technologies can create smallholder dependency on agribusiness for the continued supply of inputs. By this mechanism, contract farming can give rise to smallholder production that is unable to reproduce itself outside its relationship with the agro-industry (McMichael 2013).

Glover (1987) made an insightful point that, apart from straightforward technology transfer, outgrowers gain experience of 'the system' through contract farming. Outgrowers can become astute in learning how the market works, learning how to account and how to run their farm more like a business. Even an unfavourable situation can have positive effects if the outgrowers have the freedom to apply their knowledge of the situation in another circumstance.

Moreover, provision of inputs to the cultivation of the contractual crop is envisaged to produce spillover effects to other crops, or to farmers who do not participate in contract farming schemes. The proponents of contracting therefore see the transfer of technology as central to intensify smallholder productivity also outside the scope of the contract (Eaton and Shepherd 2001; Da Silva 2005). If the technologies or inputs are specific to a certain crops, the spillover effects can, however, be minimal (Eaton and Shepherd 2001). In addition, scholars have argued that technology is not socially neutral (Bernstein 2010; Patel 2013).

2.15 Maize Production in Ghana

In Ghana, maize is the largest staple crop and is the mainstay of the diet of the majority of Ghanaians, because it is the base for several traditional food preparations such as banku, kenkey, tuozafi etc. (Morris *et al.*, 1999). Additionally, it represents the second largest commodity crop in the country, after cocoa (ISSER, 2012). Maize is also the main component for poultry and livestock feed. Maize accounts for 50–60% of the total cereal production in Ghana (ISSER, 2012). The total average annual maize production in Ghana between 2007 and 2012 was 1.5 million MT (MoFA, 2012), which indicates that maize supply in Ghana has steadily been increasing over the past few years.

In terms of both harvest and sales value, maize is an important cash crop in Ghana. It is produced in all the ecological regions in Ghana, namely the Forest, Coastal Savannah, Forest Savannah transition, Guinea Savannah, Sudan Savannah and Sahel Savannah. In the Ghana Living Standard Survey (GLSS, 2000), categorically, there are three ecological zones, the northern savannah, coastal savannah and forest zones. In the forest zone the climate is dominated most of year by moist air and conventional rainfall is frequent. The rainfall is usually between 1000 and 2000 cm per annum, falling in two seasons with only a short dry season of reduced rainfall between them. In Southern Ghana where this condition is prevalent two cropping seasons of maize are possible. The savannah areas may have two short rainy seasons and a pronounced intervening dry season, as in the coastal areas, or a medium, lengthy rainy season and a long dry season as found in most parts of Northern Ghana. Here there is only one season for maize production

Maize production also cuts across all the ten (10) regions of Ghana but the Eastern, Ashanti, Central, Brong-Ahafo and the Northern Regions are the five major maize growing areas in Ghana (SRID of MoFA, 2010). Maize is the largest staple crop cultivated in Ghana and contributes significantly to consumer diets. It is also used in the preparation of traditional dishes such as tuozaafi, banku and kenkey. Maize is produced mostly by small-scale farmers using simple hand tools such as hoe and cutlass. Very few commercial maize farms are in operation presently in Ghana (e.g Ejura Farms). The level of production on individual farms is very low, hence the need to increase productivity through science and technology.

Maize is the most important cereal crop on the domestic market in Ghana but its yield recorded by the Ministry of Agriculture in 2010 was 1.9 Mt/ha against an estimated achievable yield of around 2.5- Mt/ha (MoFA, 2010).

While there is no recent reliable data for maize used in animal feed, the COG estimates that 85% of all maize grown in Ghana is destined for human consumption and the remaining 15% is used for animal feeding sector (mainly poultry). Thus, to meet the increasing demands of maize, farmers may have to adopt improved production and handling systems.

2.16 Constraints faced by maize farmers

Maize farmers go through a number of challenges in their production process. For instance, lack of finance among maize producers was a major challenge recognized by the Government of Kenya in 2011. This necessitated the Agricultural Finance Corporation (AFC), the co-operative movement and Cooperative Bank of Kenya to make considerable efforts to provide affordable credit to maize farmers (Ali-Olubanda, 2011; Ajana and Igbokwe, 2011). According to them, lack of enough financial credit translated into inadequate working capital.

According to Gadzirayi et al., (2006), high cost of inputs such as fertilizer and seeds poses a serious challenge to maize farmers. As a result, farmers are compelled to buy these inputs during off-peak season when the prices are a little bit lower than planting season.

Another constraint facing maize farmers is the selection of seed varieties to use due to the presence of many seed varieties in the markets from different seed companies, which have created an avenue for unscrupulous vendors to sell uncertified seeds to farmers (Ali-Olubanda, 2011). CNFA, (2005) also reported similar challenge that the choice of seed varieties in Western Province was a major challenge for most farmers due to the existence of many seed companies with many seed varieties in the market and some seed varieties were not tested to determine the viability on the farms and the extension officers were not familiar with them. Farmers were therefore confused on which seed variety to buy because of the presence of numerous varieties of maize seeds in the market. The availability of many seed varieties in the country is due to government failures to regulate the marketing of farm inputs as it was during the implementation of Structural Adjustment Programmes (Ali-Olubanda, 2011).

According to Javan and Samson (2015), poor storage facilities were also a major constraint faced by maize farmers in Kenya. According to them, a total of 53.1% of the maize was damaged by weevils due to poor storage facilities, while 30.3% of maize stored was damaged by rodents, a further total of 8.0% of the maize was lost through theft and 8.6% by aflatoxins. Maize storage is important because it bridges the gap between surplus at harvest time and scarcity during the post-harvest period.

Poor infrastructures such as market facilities and road networks are the physical challenges affecting farmers, inadequate capacity of the actors and their institutions as well as unfavorable policy environment (ECAMAW, 2005). Very little maize is sold in the international markets rather than local and regional markets but returns to farmers are very low and unstable (Kilimi *et al.*, 2004); this demoralises the maize producers from actively engaging in maize productivity fully.

CHAPTER THREE

METHODOLOGY OF THE STUDY

3.0 Introduction

This chapter presents the description of the study area, population of the study, sampling technique and sample size. The chapter also looked at data collection instruments and techniques as well as data analysis. The theoretical framework of adoption and variable definitions were not left out. The chapter also discusses the models used and the approaches used in the estimation of the models. According to Panneerselvam (2009), methodology is a system of models, procedures and techniques used to find the results of a research problem.

3.1 Study area

3.1.1 Description of study area

The Northern region, which occupies an area of about 70,384 square kilometres is the largest region in Ghana in terms of land mass. It shares boundaries with the Upper East and the Upper West regions to the north, the Brong Ahafo and the Volta regions to the south, Togo to the east, and Côte d'Ivoire to the west. The land is mostly low lying except in the northeastern corner with the Gambaga escarpment and along the western corridor. The region is drained by the Black and White Volta Rivers and their tributaries such as the Nasia and Daka rivers.

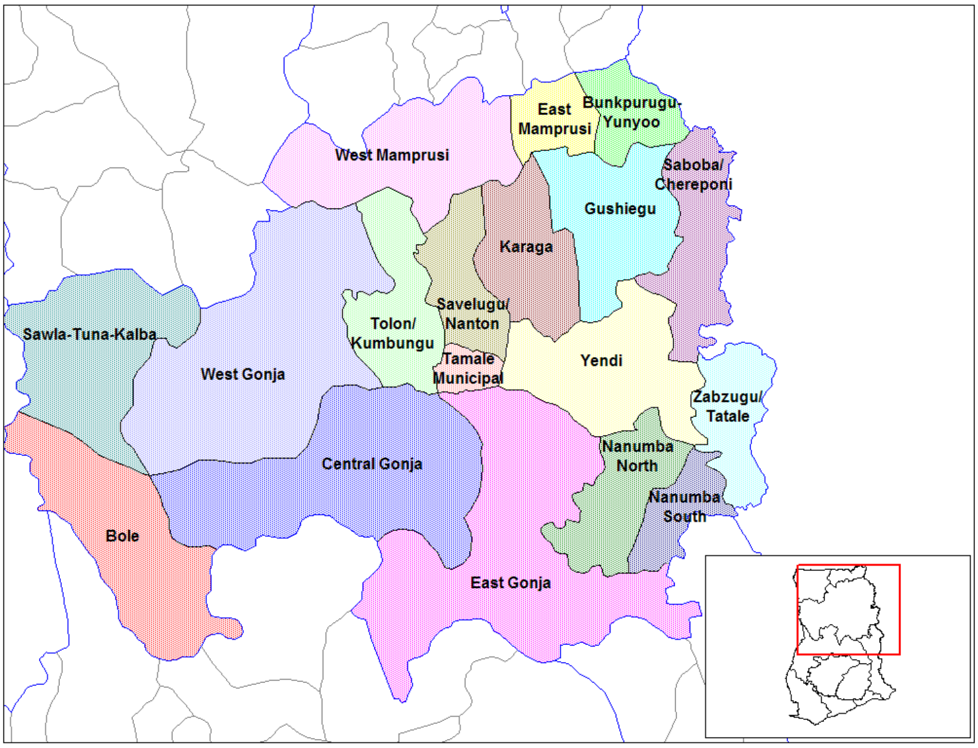

Figure 3.1: Study area and districts in the Northern Region, Ghana.

Source: http://en.wikipedia.org/wiki/Northern_Region_ (Ghana)

3.1.2 Climate

The climate of the region is relatively dry, with a single rainy season that begins in May and ends in October. The amount of rainfall recorded annually varies between 750 millimetres and 1,050 millimetres. The dry season starts in November and ends in March/April with maximum temperatures occurring towards the end of the dry season (March-April) and minimum temperatures in December and January. The harmattan winds, which occur from December to early February, have a considerable effect on temperatures in the region, making them vary between 14^{o}C at night and 40^{o}C during the day. Humidity is very low, aggravating the effect of the daytime heat. The main vegetation is grassland, interspersed with guinea savannah woodland, characterised by drought-resistant trees such as acacia, (Acacia longifolia), mango (Mangifera), baobab

(Adansonia digitata Linn), shea nut (Vitellaria paradoxa), dawadawa, and neem (Azadirachta indica).

3.1.3 Population Size and Growth

Northern region has a total population of 2,479,461 in 2010 with more females (1,249,574) than males (1,229,887). The population of the region increased by 36.2 percent between 2000 and 2010, making it the fastest growing region in the country after the Central (38.1 %) and Greater Accra (38.0 %) regions.

In 1960, the population of the Northern region was 531,573, increased to 727,618 in 1970 and to 1,164,583 in 1984 representing over 50 percent increase in 24 years. The region recorded an intercensal growth rate of 2.9 percent between 2000 and 2010. This is a slight increase over the 2.8 percent of the period 1984 to 2000. Prior to 2000, the annual intercensal growth rate of the region has been above 3 percent (3.2 percent between 1960 and 1970 and 3.4 percent between 1970 and 1984). The region's share of the national population is 10.1 percent, making it the fourth largest in terms of population after the Ashanti (19.4%), Greater Accra (16.3%) and Eastern (10.7%) regions.

Table 3.1: Population size and growth, 1960-2010

Year	Population	% increase	% share of	Intercensal growth rate
1960	531573	-	7.9	-
1970	727618	36.9	8.5	3.2
1984	1164583	60.1	9.5	3.4
2000	1820806	56.3	9.6	2.8
2010	2479461	36.2	10.1	2.9

Source: Ghana Statistical Service, Population census reports (2012)

3.1.4 Economy and Living Conditions

The majority of people in the region are engaged in agriculture. The crops that they produce include yam, maize, millet, guinea corn, rice, groundnuts, beans, soya beans and cowpea. At Gushie in the Savelugu-Nanton District, there is a large plantation of grafted mangoes cultivated by outgrowers. Bontanga in the Tolon Kumbungu District has a big irrigation dam where farmers engage in large-scale rice cultivation during the dry season.Daboya in the newly created North Gonja District (which was carved out of the West Gonja District) is noted for the production of good quality yarn for sewing smocks. Some of the people of Daboya are also engaged in salt mining. Following the discovery of an abundant deposit of lime, a cement factory (SAVACEM) has been located at Buipe, in the Central Gonja District. Buipe is also where a shea nut processing factory is located, as well as the Bulk Oil Storage & Transport (BOST) Company. This company supplies the northern part of the country with petroleum products. At Sheini, in the newly created Tatale San guli District, feasibility studies indicate abundant deposits of both iron ore and gold. There is surface gold mining popularly known as “galamsey” in the Kui community in the Bole District which has attracted a lot of youth from many parts of the country. Many women in the region are engaged in retail trade. At Kukuo, a suburb of Tamale, there is a Teaching Hospital that not only provides health services for the people of the Metropolis and the region as a whole, but also serves as a referral point for patients from other health facilities. The satellite campuses of the Faculty of Agriculture and the School of Medicine and Health Science of the University for Development Studies are situated at Nyankpala in the Tolon Kumbungu District and Dungu, a suburb of Tamale, respectively.

3.2 Population of the study

The population of the study was essentially the rural households of Northern Region of Ghana. Specifically, six districts (Karaga, West Mampurisi, Kpandai, Sawla-Tuna-Kalba, Cheriponi, and West Gonja) formed the study unit.

3.3 Sampling Techniques and Size

Determination of sample size was done by considering the population of farmers using improved farm technologies. According to Kothari (2004), the desired sample size is determined by the following formula:

$$n = \frac{Z^2 . p . q . N}{(e)^2 \ (N-1) + (Z)^2 \ . p . q} \qquad (3.1)$$

Where n = sample size, z = confidence level, p = proportion of the population, q= 1-p, e is the allowable error and N is the population size.

The proportion of population using improved farm technologies was not known. In that case, Kothari (2004) recommends ‘p’ to take the value of 0.5 in which case ‘n’ will be the maximum and the sample will yield at least the desired precision. Therefore, $p = 0.5$, $q = 1 - 0.5 = 0.5$, $N = 1500$ *and* $N - 1 = 1499$, $z = 1.96$ *at* 95% confidence level a $e = 5\%$.

Therefore, $n = \frac{(1.96)^2 \ (0.5) \ (0.5) \ (1500)}{(0.05)^2 \ (1499) + 1.96^2 \ (0.5) \ (0.5)} = \frac{1440.6}{3.7475 + 0.9604} = 305.996304$ which are about 306. Therefore, a sample of 306 respondents was required for the study. However, six questionnaires did not return after administering them. This necessitated the use of a sample size of 300.

The selection of the respondents involved multi-stage sampling technique. In the first stage, six districts were purposively selected in Northern Region of Ghana based on intensity of maize production, accessibility and agro ecology. According to GSS (2010), the total number of communities in the six districts was 1099 (i.e. Kariga, West Mampurisi, Kpandai, Sawla-Tuna-Canada, Cheriponi and West Gonja respectively have 184, 142, 244, 278, 195 and 56). But for financial reasons, a proportionate sampling method was used to select five (5) communities in each district, giving a total of thirty (30) communities in the second stage. In the third stage, simple random sampling was used to select ten (10) household head from each community except Kpandai district where 11 household heads were selected in each community because of the large number of communities in that district. This gave a total sample size of three hundred (305) respondents which fell short of one person from the number gotten from the formula. Hence, one person was conveniently added to give a total of 306 respondents.

Table 3.2 Summary of sample size

No	Districts	Communities	No. of farmers
1	Karaga	Dibulo, Sadugu, Sung, Kpasablo and Gbaliga	50
2	West Mampurisi	Binduri, Sayoo, Silinga, Yawuku and Wulugu	50
3	Kpandai	Nchaponi, Kateijeli, Buya, Nkanchina and Mile 70	55
4	Sawla-Tuna-Kalba	Gindabuo, Bale, Gombey, Poliyili and Pongeri	50
5	Cheriponi	Tacheku, Sagbana, Jayangu, Naweiku and Naja	50
6	West Gonja	Kango, Tailape, Yipala, Damango canteen and Janfaru	50
Total	6	30	305

Source: Author's construct from field survey

3.4 Data Collection instruments and Techniques

Primary data were collected for this research work. Data were collected directly from the maize farmers using semi-structured questionnaires.

3.5 Data Analysis

The econometric software STATA and SPSS was used to analyze the data collected. To achieve objective one, descriptive statistics was used to identify improved agricultural technologies being adopted and the extent of adoption. The study employed a multivariate probit model to investigate factors that influence the adoption of improved technologies. Poisson model with endogenous treatment was used to measure the effect of contract farming participation on the adoption of improved technologies. I also examined factors influencing farmers participation in CF using a probit model while Kendall's coefficient of concordance (W) was used to explore the constraints facing maize farmer in the study area.

3.6 Theoretical Models of Adoption Studies

The theory of adoption of new technology has formed the basis for most of the research works on farmers' behaviour in taking up improved technologies to enhance their farming activities. Adoption theory posits that the adoption of a new technology is dependent upon demographic, institutional, economic or endowment related factors and psychological factors (Rogers, 1983). According to Feder *et al.*, (1985) the demographic factors affecting adoption include age, family size, literacy, sex, experience etc.; economic factors include income, land tenure, farm size, etc.; institutional factors include credit access, access to market, access to extension, etc.; and psychological factors include awareness, attitude towards risk, interest rate etc. This study is based on the theory of adoption and seeks to produce relevant information to determinants of contract farming participation and its effect on adoption of improved farm technologies. This study used the Probit model, Multivariate Probit model, Poisson model with endogenous treatment and Kendall's Coefficient of concordance in the analysis. Osgood (2000), and Slymen *et al.*, (2006) used the Poisson regression to perform analysis using count data.

3.6.1 The Multivariate Pobit Model

In a single-equation statistical model, information on a farmer's adoption of an Improved Farm Technologies (IFTs) does not alter the likelihood of his adopting another IFT. However, the multivariate probit (MVP) approach simultaneously models the influence of the set of explanatory variables on each of the different practices, while allowing for the potential correlation between unobserved disturbances, as well as the relationship between the adoptions of different technologies (Belderbos *et al.*, 2004). One source of correlation may be complementarity (positive correlation) or substitutability (negative correlation) between different technologies (ibid). Failure to capture unobserved factors and interrelationships among adoption decisions regarding different technologies will lead to bias and inefficient estimates (Greene, 2008).

Therefore, in this study, a multivariate probit model is used to examine factors that influence the adoption of IFTs. According to Capellari and Jenkins (2003), the multivariate probit is given as

$$y_{im}^{*} = \beta X_{im} + \varepsilon_{im}, \quad m = 1 \ldots M \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.2)$$

$y_{im} = 1 \; if \; y_{im}^{*} > 0 \; and \; 0 \; otherwise$, ε_{im}, $m = 1 \ldots\ldots M$ are error terms distributed as multivariate normal, each with a mean of zero, and variance-covariance matrix V, where V has values of 1 on the leading diagonal and correlations. Capellari and Jenkins (2003) noted that the model has a structure similar to that of a seemingly unrelated regression (SUR) model, except that the dependent variables are dichotomous. The Geweke-

Hajiuassiliou-Keane (GHK) smooth recursive conditioning simulator is used for estimating the multivariate probit model (Borsch-Supan and Hajivassiliou, 1993; Capellari and Jenkins, 2003).

If y_j^i denote farmer $I^{'s}$ binary response outcome associated with each j type of agricultural technology, for $j = 1$such that y_j^i is 1 if farmer I adopts agricultural technology j and 0 otherwise. Ulimwengu and Sanyal (2011) showed that the multivariate probit model can be specified as a linear combination of deterministic and stochastic component:

$$y_j^i = x^{'}\beta_j + \varepsilon_j \quad \text{...}(3.3)$$

Where $x = (1, x, ..., x_p)$ is a vector of p covariates, which do not differ and $\beta_j = (\beta_{j0}, \beta_{jp})$ is corresponding vector of parameters to be estimated. The error term, ε_j consists of those unobservable factors affecting the marginal probability of adoption of j agricultural technology. They added that each ε_j is drawn from a J-variate normal distribution with zero conditional mean and variance normalized to unity (for parameter identification): $\Omega \sim N(\,0,\, \Omega)$ with the variance covariance matrix given by:

$$\Omega = \begin{bmatrix} 1 & P_{12} & ...P_{1j} \\ P_{21} & 1 & ...P_{2j} \\ P_{j1} & P_{j2} & ....1 \end{bmatrix} \quad \text{..}(3.4)$$

The off-diagonal elements in the covariate matrix P_{sj} represent the unobserved correlation between the stochastic component of the s^{th} and the j^{th} types of the agricultural technology (innovations).

3.6.1.1 Empirical Specification of the MVP Model

Based on the theoretical model the empirical model that examines factors that influence the adoption of IFTs are given in the equations below;

$$Y_{ji}^{*} = \sum_{m=1}^{m=4} X_{mi}\beta_{mj} + \varepsilon_{ji}$$

where j is the type of agricultural technology, $X_m = X_1, X_2, \ldots X_8$ are socioeconomic factors such as age, education, extension visit, land tenure, membership of farmer based organization (FBOs), farm size, household size and credit that influence the dependent variable (i.e. adoption of IFTs). $Y_j^{*} = Y_1^{*}, Y_2^{*}, Y_3^{*}$ *and* Y_4^{*} are the adoption of herbicide use for land preparation, improved maize varieties, planting in lines and maize-legume rotation respectively. Also, $\beta_m = \beta_1, \beta_2, \ldots \beta_8$ are the parameters to be estimated and $\varepsilon_j = \varepsilon_1, \varepsilon_2, \ldots \varepsilon_8$ are error terms attributed as multivariate normal.

3.6.2 Poisson Model with Endogenous Treatment

In this study, to estimate the effect of contract farming participation on the adoption of Improved Farm Technologies (IFTs), Poisson model with endogenous treatment was used. According to Greene (1997), a count data model is suitable for this type. Let the number of IFTs adopted be Y. Following Greene (1997), the variable IFTs can be modeled as a random variable drawn from the Poisson distribution. Formally, the Poisson model is given as follows:

$$\Pr(Y_i = y \mid X_i) = \frac{\exp(-\lambda)\lambda}{y!} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.5)$$

λ is the expected level of IFTs adopted within a given time period, $E(Y_i)$. It is assumed that the expected level of adoption of IFTs depends on contract farming as well as other farmer and farm specific factors as represented in equation (3.6)

$$\lambda = \exp(b_0 + b_1 \ln X_1 + b_2 \ln X_2 + ... + b_k \ln X_k + e) \text{ ....(3.6)}$$

Contract farming is considered to be an important factor that influences adoption of IFTs among maize farmers in Northern Region. However, being a contract farmer is the prerogative of the farmer. Farmers who enter contract farming may self-select into that population on the basis of certain traits (e.g. motivation, entrepreneurial ability, risk attitudes and adventurousness) that will ultimately affect the level of adoption, whether or not to take part in contract farming. This fact may affect rigorous comparison between the two groups of farmers. If this self-selection issue is not accounted for, it may be possible to attribute to contract farming differences which are at least partially explained by differences in the contract farmers themselves.

To account for sample selection in count data models, a number of techniques have been developed. The various ideas of sample selection or treatment effect in count data models follow from Heckman (1979), who proposed a two-step approach to correct for sample selection bias. Greene (1994) extended Heckman's fundamental approach to a case where the outcome variable is a count with typical values ranging from 0 to n; where n is the highest number of IFTs adopted. The idea is to use the two-step methodology of Heckman, where the first step adopts a Probit maximum likelihood estimator to model the treatment or selection equation and the second step now adopts a Poisson equation to model the outcome variable (in this case, adoption of IFTs). It is important to remember that the first step produces the Inverse Mill's Ratio (IMR) which is then incorporated in the second step Poisson estimation. Terza (1998) disagreed with some aspects of Greene (1994) specification. His point of departure is that there was no reason why the IMR should enter the Poisson regression model linearly. Based on this, he recommended an approach where heterogeneity is introduced directly into the conditional mean function of the Poisson model. Following this criticism, (Greene, 1998; Greene, 1997) suggested a slightly modified approach that defends his 1994 model. Here, the outcome model is estimated by a non-linear estimator.

In this study, the method used by (Greene, 1998; Greene, 1997) is adopted, where an endogenous treatment-regression model for the dependent variable (in this case, number of IFTs adopted) is specified. This specification allows for a well-defined correlation structure between the unobservable variables that affect contract farming as well as adoption. The model of interest is given by equation (3.7) below:

$$E(Y_i | X_i, c_i, e_i) = \exp(X_i' b + \delta c_i + e_i) \quad \text{.....................................(3.7)}$$

X_i is a vector of covariates that influence the level of adoption. The probability density function for Y_i conditional on the treatment c_i, the covariates X_i and error e_i is given by (3.8)

$$E(Y_i | X_i, c_i, e_i) = \frac{\exp\{(-\exp(X_i' b + \delta c_i + e_i)\}\{\exp(X_i' b + \delta c_i + e_i)\}^{Y_i}}{Y_i !} \quad \text{...(3.8)}$$

The treatment (contract farming) is determined by (3.9)

$$c_i = \begin{cases} 1 \ \ if \ \ W_i\gamma + u_i > 0 \\ 0 \ \ if \ \ otherwise \end{cases} \quad \text{...(3.9)}$$

W_i is a vector of covariates that influence the decision to enter into contract farming. The error terms e_i *and* u_i follow bivariate normal distribution with mean zero and covariance matrix given by (6)

$$\begin{bmatrix} \sigma^2 & \sigma\rho \\ \rho\sigma & 1 \end{bmatrix} \quad \text{...(3.10)}$$

The covariates vectors X_i and W_i are exogenous. According to Greene (1998) and Terza (1998) estimation of the parameters in such models may be done by using maximum likelihood.

3.6.2.1 Empirical Specification of the Probit Model

Based on the theoretical model the empirical model that assesses that effects of contract farming participation on the adoption of IFTs are given in the two equations below;

$$Contract\ (C) = \beta_0 + \beta_1 l\_tenure + \beta_2 mfbo + \beta_3 awareness + \beta_4 d\_mkt + \beta_5 f\_size + \beta_6 sizpcl + \beta_7 sex + u_i$$

Where the covariates are defined as land tenure, membership of farmer based organisation, awareness, distance to market, farm size, size of parcel and sex respectively.

$$Adoption\ (Y) = \beta_0 + \beta_1 age + \beta_2 educ + \beta_3 credit + \beta_4 ex\_visit + \beta_5 \exp + \beta_6 contract + e_i$$

The covariates are defined as age, education, credit, extension visit, experience and contract farming respectively.

Where Y is a count variable ranging from 0 if a farmer failed to adopt any of the IFTs up to n, the highest number of IFTs.

3.6.3 The Probit Model

The dependent variables in the adoption model are 0, 1 dummy variables, which indicate one if a farmer participate in contract farming and zero if otherwise. The appropriate model is a discrete choice model such as the probit model (Gujurati, 2004). Following Gujarati (2004), to motivate the probability model, the decision of the i^{th} farmer to participate in contract farming or not depends on an unobservable utility index I. This utility index is a latent variable which is determined by a number of explanatory variables (e.g. age, sex, education, land tenure, membership of farmer based organization (FBO), farm size etc). The index, I_i is expressed as

$$I_i = \beta_1 + \beta_2 X_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.11)$$

In establishing the relation between the unobservable utility index and the actual decision making on whether to participate in contract farming, a threshold level of the utility index is assumed, say I_i^*.

$$\begin{matrix} if\ I_i > I_i^*,\ I = 1 \\ if\ I_i \le I_i^*\ \ I = 0 \end{matrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.12)$$

Given the assumption of normality, the probability that is less than or equal to can be computed from the standardized normal cumulative density function (CDF) as

$$\begin{aligned} P_i &= P(Y = 1|X) = P\ (I_i^* \le I_i) = P(Z_i \le \beta_i + \beta_2 X_i,\ \ldots\ \beta_n) \\ &= F\ (\beta_1 + \beta_2 X_i\ \ \ldots\ldots\beta_n X_n\ \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.13) \end{aligned}$$

Where $P(Y = 1|X)$ means the probability that an event occurs given the values of the explanatory variables and where Z_i is the standardized normal value, that is, $Z \sim N(0, \delta^2)$. F is the standard normal CDF. Taking the inverse of the CDF gives

$$I_i = F^{-1}(P_i) = \beta_1 + \beta_2 X_2 \ldots\ldots\ldots\beta_n X_n \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.14)$$

where F^{-1} is the inverse of the normal CDF.

3.6.3.1 Empirical Specification of the Probit Model

Based on the conceptual framework, the empirical model is estimated using the farmers' characteristics plausibly assumed to influence the participation in contract farming. The covariates include farm and farmer characteristics such as age, sex, education, land tenure, farm size, farming experience etc. The empirical model for participation in contract farming is specified below:

$$Y_i = \beta_0 + \beta_1 age + \beta\ educ + \beta_3 l\_tenure + \beta_4 mfbo + \beta_5 d\_mkt + \beta_6 f\_size + \beta_7 sizpcl + \beta_8 sex + \beta_9 risk + \beta_{10} credit + \beta_{11} i\_rate + \beta_{12} \exp + \varepsilon_i .$$

The variables are defined as age, education, land tenure, membership of farmer based organsation, distance to market, farm size, size of parcel, sex, attitude towards risk, credit, interest rate and experience respectively.

Where Y_i is participation in contract farming and ε_i is sample error term.

3.6.3.2 Testing of Hypotheses

All the covariates used in the model are hypothesized on facts and expectations. For the right conclusion to be drawn, the necessary hypotheses will have to be tested.

Ho: All the covariates have no influence on contract farming participation.

Ha: At least one of the covariates influence the participation in contract farming.

Where Ho = the null hypothesis and Ha = the alternate hypothesis.

3.6.4 Kendall's Coefficient of Concordance

The Kendall's Coefficient of Concordance (W) analysis is a statistical procedure used to rank (in this context) a given set of farming practices from the most important to the least important, and then measures the degree of agreement/concordance between the respondents (Edwards, 1964).

The formula for the coefficient of concordance (W) is given as:

$$W = \frac{n\left[T^2 - (\sum T)^2 / n\right]}{nm^2\left(n^2 - 1\right)} \quad or \quad nT / nm^2\left(n^2 - 1\right) \text{ ....(3.15)}$$

Where:

T = sum of ranks for the factors being ranked;

m = number of respondents; and

n = number of factors being ranked

Note that W is an index that measures the ratio of the observed variance of the sum of ranks and the maximum possible variance of the sum of ranks.

The maximum variance (T) is given by:

$$T = m^2\,(n^2 - 1)/12 \text{ ....(3.16)}$$

$$Var\,T = \left[\sum T^2 - \frac{(\sum T)^2}{n}\right] \text{ ....(3.17)}$$

Where the variables are as defined.

The idea behind this index is to find the sum of ranks given to each item (farmers constraints) being ranked by respondents and then examine the variability of this sum. If the rankings are in perfect agreement, the variability among these sums will be a maximum. The constraint are ranked according to the most important to the least important using numerals 1,2,3,4,5…….n, in that order. The least score rank is the most important while the one with the highest score is ranked as the least important. The total rank score computed is then used to calculate for the Coefficient of Concordance (W) to measure the degree of agreement in the rankings. The limits for W cannot exceed 1.00

and cannot be negative. That is, it can only be positive in sign and ranges from 0 to1. It will be 1.00 when the ranks assigned by each respondent are the same as those assigned by other respondents and it will be 0.00 when there is a maximum disagreement among the respondents.

3.6.4.1 Hypotheses and Significant Test for W: (F-Test)

Ho: There is no agreement among the rankings of the constraints by the farmers.

Ha: There is agreement among the rankings of the constraints by the farmers.

Where; Ho and Ha denote null and alternate hypotheses respectively.

The Coefficient of Concordance (W) may then be tested for significance in terms of the F distribution as follows:

$F - ratio(F_c) = (m-1) \times W / 1 - W$ ....(3.18)

Degree of freedom for numerator (df) = $(n-1)-(2/m)$ ....(3.19)

Degree of freedom for denominator (df) = $(m-1)\{(n-1)-(2/m)\}$.....(3.20)

In this study, farmers were asked to rank in order of importance, some of the constraints they faced in farming by assigning 1 to the most important and 8 to the least important. The constraints are as follows: lack of improved seeds; lack of access to tractor; high cost of inputs; lack of weather information for planting; low yield; lack of access to credit; low soil fertility; and drought. The Kendall's Coefficient of concordance has been applied to consumer preference for rice by Alhassan *et al.*, (2008).

Table 3.3 Constraints faced by farmers in maize production

Constraints	Mean rank	Rank
Lack of improved seeds	XXXX	XXXX
Lack of access to tractor	XXXX	XXXX
High cost of inputs	XXXX	XXXX
Lack of weather info. for planting	XXXX	XXXX
Low yield	XXXX	XXXX
Lack of access to credit	XXXX	XXXX
Low soil fertility	XXXX	XXXX
Drought	XXXX	XXXX

Source: Author's construct from field survey

3.7 Variables Definition and Hypothesis

3.7.1 Dependent Variables

The dependent variables used in this study include; herbicide used for land preparation, improved maize varieties, planting in lines and maize-legume rotation.

3.7.2 Explanatory Variables

Regarding the criteria for choosing explanatory variables, there is no firm economic theory that clearly dictates the choice of independent variables used in adoption studies as reported by Langyintuo and Mekuria (2005), Adesina and Zinnah, (1993). In this specific model, the selection of the variables which influence contract farming participation and its effect on adoption of improved farm technologies (IFTs) are based on prior literatures which are categorized as the following.

i) Farmers Socio-economic Variables: sex, age of a household head, farming experience and educational level of a household head.

ii) Institution Related Variables: membership of farmer-based organization, access to credit, access to extension service, distance to market etc.

iii) Farmers Endowment Variables: land tenure, farm size, family size, etc.

The details of explanatory variables that influence contract farming participation and its effect on the adoption of IFTs are hypothesized as follows;

1. Sex of household: In Ghana, households are usually headed by males who are always considered as the decision-makers in terms of resource use. Females only make decisions in the absence of males. There is gender discrimination when it comes to decisions concerning resource use particularly, in extension message delivery due to resource limitations (Chiputwa *et al.,* 2011). Therefore male farmers are more likely to adopt IFTs than their female counterparts. Adoption is therefore expected to have a positive marginal effect.
2. Age of a household head: This is likely to influence adoption decision positively because the older the farmer, the greater his/her chances of getting information on farm management practices. Donkoh and Awuni (2011) stated that older people are likely to be mature, better organisers and may also have contacts with extension agents and researchers which make them have greater probability of adopting technologies.
3. Education: Educated farmers are able to read both print and electronic media. This gives them the comparative advantage over their illiterate counterparts in the use of a technique as observed in many studies (Clearfield and Osgood, 1986; Manyong *et al*., 1999; FAO, 2001; Clay *et al.,* 2002; Place *et al*., 2002; Haggblade and Tembo, 2002). Because they can search for information from different sources, they are better placed to evaluate, understand and update their knowledge of technology more rapidly and follow the procedures relating to the

use of the technology more easily and thus adopt it earlier compared to their illiterate counterparts (Jallor, 2001; Boahene, 1995). Hence, education of a farm household head can have a positive influence on the outcome variables thereby increasing the likelihood of adoption of improved technologies.

4. Household size: This refers to the number of people cooking from the same pot. A large household is an endowment and a reliable source of labour if household members are available to work on the farm as family labour, given the labour intensive nature of agricultural technologies. Hence, household size is expected to positively affect adoption decision.
5. Farm size: This variable is expected to be positively associated with adoption of improved technologies because a farmer with a large landholding has a greater access to resources and is better able to face risks. Farmers who have large farms would easily allocate some portions to new technologies. It is therefore hypothesized to be positively correlated with adoption of improved technologies.
6. Experience: This refers to the experience gathered by a farmer as a result of the number of years of farming. It is expected to be positively correlated with adoption decision.
7. Distance to market: This refers to the distance travelled by a farmer to access a market (input and output market). The closer the market is to the farmer's farm, the greater his/her probability of adopting a technology. The reason being that easy access to the market creates an enabling environment for timely acquisition of inputs and reduces market transaction cost (Reardon and Vosti, 1997; Malla, 1999; Sanders and Cahill, 1999; Sayre *et al.,* 2001; Bekele, 2003). It is expected to be positively correlated with adoption.

8. Access to credit: Agricultural technologies may be expensive beyond the means of most smallholder farmers. Access to credit would enable farmers to buy these technologies to increase yield.
9. Extension visit: This refers to the number of times an extension officer visits farmers in a season. Through extension service, information on better farming practices is disseminated to farmers. It is therefore expected to be positively correlated with adoption.
10. Contract farming: This refers to whether the farmer is bonded to any individual, company etc. in the provision of inputs and/or the purchase of output. Positive correlation with adoption is expected.
11. Land ownership: This is the proportion of land owned by the farmer. It is an indicator of wealth and social status and influence within a community. This means that farmers who own land would be in better position to adopt improved farm technologies. Hence, it is expected to be positively associated with the decision to adopt improved farm technologies.
12. Membership of FBO: Being a member of any farmer based organization could help the farmer in easily accessing farm inputs and other related information and hence it is expected to have positively correlated with adoption.
13. Interest rate: This is the amount charged, expressed as a percentage of the principal, by a lender (i.e. a contractor, government, NGO, financial institutions, etc.) to a borrower (in this case, a farmer) for use of assets. Low interest rate is expected to be positively correlated with adoption.
14. Attitude towards risk: This describes a farmer, whether he/she is risk averse or risk loving. According to Lipton and Longhurst (1989), small-scale farmers produce under very high levels of uncertainty induced by natural hazards like

weather, pests, diseases, natural disasters, market fluctuations and social uncertainty. Technology adoption also usually comes with uncertainties. Innovators and early adopters are perceived to be risk lovers while late adopters and laggards tend to be risk averse (Rogers, 1983).

15. Awareness: This has to do with whether a farmer knows the existence of a given technology. Adoption of a technology begins with awareness, and then goes through interest, evaluation, acceptance, trial and then finally adoption (Rogers, 1983). Therefore, awareness is expected to have positive correlation with adoption.

Table 3.4 Summary of exogenous variables

Variable	Definition	Unit of Measurement	Sign
Sex	Sex of household head	1 if male; 0 otherwise	+
Age	Age of household head	Years	+
Education	No. of Years of formal educ.	Years	+
HH size	No. of family members	Number	+
Farm size	Farm size	Hectares	-
Farming exp	Farming experience	Years	+
Dist. Mkt	Distance to main market	Kilometres	-
Credit	Access to credit	Gh¢	+
Ext. visit	No. of times of extension visit	Number	+
CF	Contract farming involvement	1 if under contract; 0 otherwise	+
Land tenure	Land tenure	1 if owned land; 0 otherwise	+
Memb. FBOs	Farmer based org. membership	1 if a member; 0 otherwise	+
Interest rate	Interest rate	1if low interest rate[1];0 otherwise	+
Risk	Attitude towards risk	1 if early adopter; 0 otherwise	-/+
Awareness	Awareness of technology	1 if aware of tech; 0 otherwise	+
Size of parcel	No. of tracts of land	Hectares	+

[1] Bench mark of interest rate is 5%

CHAPTER FOUR

RESULTS PRESENTATION AND DISCUSSION

4.0 Introduction

This chapter presents the results and discussion of the study. The results and discussions are presented in accordance with the objectives of the study. First, the levels of adoption of improved farm technologies (IFTs) are presented. This was followed by factors influencing the adoption of IFTs. The next section looks at effect of contract farming (CF) participation on the adoption of IFTs. Furthermore, factors influencing participation in CF as well as constraints faced by maize farmers in the study area were also looked at.

4.1 Socioeconomic Characteristics of Respondents

The socioeconomic characteristics of the respondents discussed in this section are the sex of the farmers, age, educational level, household size, farm size, farming experience, distance to market, access to credit, extension visit, contract farming, land tenure and membership of farmer based organization, among others. These socioeconomic variables (e.g. education, sex etc.) are relevant in the sense that it indicates whether a farmer will take part in CF or adopt improved farm technology.

The results from table 4.1 indicate that majority (59%) of the respondents were male. This is because maize cultivation is labour and cost intensive which discourages most females from investing their little share of household resources into production. Furthermore, in Ghana land is mostly owned and controlled by the male head of the household. The primary source of land in rural communities is allocated family land and it is mainly controlled by the male who is the head of the family; female rely more on household land, which is given to them by their husbands or other family members (Goldstein and Udry, 2002). From field observations, it was clear that females preferred selling or marketing the produce. Others engaged in petty trading to support their families.

From the results, it is clear that majority of the farmers (53%) had formal education while the rest (47%) had no formal education. According to Adegbola and Gardebroek (2007), educated farmers are able to better process information, allocate inputs more efficiently, and more accurately assess the profitability of new technology, compared to farmers with no education.

Land ownership is an important factor in every production activity. There is a growing shift from communal land ownership to family and individual land ownership. From the results in table 4.1, a large percentage (55.3%) of the farmers owned their land while the rest were tenants who paid some form of rent to the land owners. Most of the tenants reported that the mode of payment is food of any quantity of their choice to show appreciation of the kind gesture.

Also, majority (53.3%) of the farmers belong to FBO while the rest do not belong to FBO. Membership to FBO is an essential tool for screening loan applications and for ensuring that contracts can be enforced (Aryeetey, 2005). The group based microcredit programme allows borrowers (in this case, farmer) who cannot provide collateral, to form their own group where members are mutually liable for each other's repayments although loans are provided to individuals. Since micro-financial institutions agree not to take any legal action against defaulters, the only instrument they have against loan defaulters is joint liability, where if any member is unable to repay, other group members cannot borrow unless they assist in repaying defaulters debt (Al-Mamun *et al.*, 2011). It also makes it easier for extension officers to visit the farmers and share some knowledge in

Table 4.1 Categorical Socioeconomic Variables

Variable	Freq	%
Sex		
Male	177	59
Female	123	41
Education		
Formal	159	53
No formal	141	47
Credit		
Access	175	58.3
No access	125	41.7
Contract farming		
Contracted	159	53
Not contracted	141	47
Land tenure		
Owned	166	55.3
Rented	134	44.7
Member of FBO		
Yes	160	53.3
No	140	46.7
Awareness of CF		
Aware	169	56.3
Not aware	131	43.7
Interest rate		
High	141	47
Low	159	53
Attitude towards risk		
Early adopter	140	46.7
Late adopter	160	53.3

Source: Author's estimation from field survey, 2016

good agricultural practices with them. According to Uaiene *et al.,* (2004), membership to some association is also important for small holder farmers in that it serves as a potential for overcoming credit market failures. A large percentage (53%) of the farmers was under a contract of some sort while the rest were not. Some of those under contract were into input and output contracts where they (the farmers) were provided with inputs (i.e. fertilizer, seeds and other herbicides) to farm and also were promised to buy their farm produce respectively. Others reported that they were given loans with low interest rate to carry out their farming activities.

Again, majority (58.3%) of the farmers had access to credit while the remaining did not have access to credit. Even though farmers in the study area who had access to credit were more than those without access to credit, this phenomenon is still worrying. This is because 41.7% is not a small number. Lack of credit was a major constraint that limited 48% of the small scale farmers in India from applying fertilizers (Bhalla 1979). Credit timing, distribution and efficiency all affect adoption (Feder *et al.*, 1985).

On the awareness of the existence of contract farming, majority (56.3%) of the farmers answered in the affirmative. According to Feder *et al.* (1985) and Adegbola and Gardebroek (2007), farmers who are aware of a certain agricultural technology component will decide whether or not to adopt it by evaluating the expected economic profitability or benefit that they anticipated will be gained, taking into account the initial investment and variable costs. An agricultural technology is more likely to be adopted if the gain or profit exceeds the aggregate investment and variable costs. On the contrary, 43.7% of the respondents said they have no idea about what it was.

In terms of the interest rate, majority (53%) of the farmers reported that they will go into contract farming if the interest rate is low while 47% reported that they will go into contract when the interest rate is high. Like any other service/product, the participation in the CF programme is likely to be affected by their price. In such case, holding other factors constant, the higher the interest rate charged, the lower the demand or participation in CF would be observed (Trupp, 2002). Trupp (2002) argued that an interest rate of 5% will be ideal for small-scale farmers. The high interest rate charged on loans given to farmers by contractors will affect their farming operations.

With regards to whether a farmer is an early adopter or not, (53.3%) were early adopters. Early adopters are assumed to be risk lovers and vice versa. Early adopters are the first people to accept innovations upon hearing it. According to Shampine (1998); Basley and Case (1993), farmers have heterogeneous beliefs about new agricultural technologies and the economic profitability of new agricultural technologies is uncertain. Early adopters are farmers who adopt first, while late-adopters wait and observe the experiences of early adopters. After obtaining information about the technology from early-adopters, they decide whether or not to adopt the technology based on the economic profitability. The remaining 47% were late adopters.

With respect to the continuous variables, the results in 4.2 indicate that the ages of the respondents ranged between 18 and 90 years, with an average of 44 years. About 5.67% of the farmers were between the ages of 0 and 20 years while a larger proportion (44%) of the respondents were aged between 21 and 40 years which are the most productive stages of their lives, all other things being equal. This implies that maize production is dominated by the youth in the study area. Also, a large percentage (30.67%) of the farmers was aged between 41 and 60 years while 19.60% were above 60 years. This means that maize farming provides a source of livelihood for the aged too.

The average years of farming experience of the respondents was 24 years ranging from 5 to 50 years as shown in table 4.2. A large number (34%) of the farmers has farming experience between ten (10) and twenty (20) years. As reported by Aneani *et al.*, (2011), long years of farming experience can increase farmers' confidence in adopting improved agricultural technologies (Aneani *et al.*, 2011).

On the part of distance to market, the results show that an overwhelming majority (84.7%) of the farmers travel a distance of between 1 and 10 kilometers to access a market. Farmers who are closer to markets have a better chance being exposed to information about the potential benefits of new technologies as well as contacting extension agents, among others. From the findings, 12.3% travel a distance of between 11 and 20 kilometers while only 3% travels a distance of between 21 and 30 kilometers.

From the results in table 4.2, a large percentage (37%) of the farmers cultivated a land size of between 1 and 3 hectares. This could be attributed to the fact that, maize cultivation needs proper care and maintenance and because of resource constraints faced by farmers, it is better to farm the number of hectares that can be taken care of. Ouma and Owuor (2006) reported that most farmers in developing countries are cash trapped and hence, they need financial assistance to purchase the technologies and their complementary inputs. About 31.3% of the farmers cultivated a land size of between 4 and 6 hectares; 25.7% of them cultivated a land size of between 7 and 9 while a small percentage (6%) of the farmers cultivated above 9 hectares.

In figure 4.2, the size of the households ranges from 1 to 30 members, with an average of 12 members. A large percentage (31.3%) of the farmers has household sizes that ranged between 6-10 members. A large household is an endowment and a reliable source of labour if household members are available to work on the farm as family labour, given the labour intensive nature of agricultural technologies. About 22% of the respondents had a household size that ranged from 11 to 15 while 18.7% of the household ranged from 16 to 20 members.

Table 4.2 Continuous Socioeconomic Variables

Variable	Freq	%
Age (years)		
0- 20	17	5.7
21-40	132	44.0
41-60	92	30.7
Above 60	59	19.6
Experience		
Less than 10	43	14.3
10-20	102	34.0
21-30	64	21.3
31-40	55	18.3
Above 40	36	12.0
Distance to market		
1-10	254	84.7
11-20	37	12.3
21-30	9	3.0
Farm size		
1-3	111	37.0
4-6	94	31.3
7-9	77	25.7
Above 9	18	6.0
Household size		
1-5	46	15.3
6-10	94	31.3
11-15	66	22.0
16-20	56	18.7
Above 20	38	12.7
Extension visit		
1-3	93	31.0
4-6	166	55.3
Above 6	41	13.7
Parcel size		
1	98	32.7
2	122	40.7
3	67	22.3
4	13	4.3

Source: Author's estimation from field survey, 2016

From table 4.2, majority of the farmers (55.3%) had extension visits which ranged from 4 to 6 times. Pattanayak *et al*. (2003) argued that extension services provided by the government, NGOs, and other stakeholders play a very important role in the adoption of new agricultural technologies. Farmers who are exposed to information about new technologies by extension agents (through training, group discussion, plots demonstration, and other form of information delivery) tend to adopt new technologies.

4.2 Adoption levels of improved farm technologies

The first objective of this study was to investigate the improved technologies adopted and their levels of adoption in the study area. Adoption of improved technologies refers to a process where a farmer stops using a local (traditional) technology and uses a new (improved) technology (Doss, 2003).

The technologies adopted and practiced by maize farmers in the study area are shown in table 4.3. Farmers practiced one or more of the named technologies.

Table 4.3: Levels of Adoption of Technologies

Technology	Frequency	Percentage
Herbicide use for land preparation	177	25.84
Improved varieties	175	25.55
Planting in rows	164	23.94
Maize-Legume rotation	169	24.67
Total	685	100

Source: Author’s estimation from field survey, 2016

From the results in table 4.3, a large percentage (26%) of the farmers adopted herbicide use for land preparation. Herbicide application at planting time makes weeding easier. That is, with the use of non-selective herbicides, all weeds can be removed in single operation. Also, 26% of the farmers adopted improved varieties. Improved varieties have the potential to increase production, as well as increase income. This goes a long way to improve the living standard of farmers. Furthermore, a large percentage (24%) of the farmers adopted planting in rows. Planting in rows ensures that plants have adequate planting space which reduces competition for water, light, nutrients etc. which are vital for plants growth and development. The standard spacing of maize plants is 75cm between rows and 30cm between hills when allowing one seed per hill or 75cm between rows and 60cm between hills when allowing two seeds per hill.

4.3 Multivariate probit (MVP) model results

Having looked at the levels of technology adoption, I now look at factors influencing the adoption IFTs using MVP model. The MVP regression allows the estimation of several correlation binary choices jointly (Greene, 2003). The MVP model takes into account the potential interdependence in technology choice and the possible correlation in the adoption of alternative improved farm technologies. The probability of adoption of any particular technology is estimated conditional on the choice of any other technology.

The MVP model is estimated using the maximum likelihood method. The model fits the data reasonably well – the Wald chi^2 (32) =114.44, p=0.0000 of the hypothesis that all regression coefficients in each equation are jointly equal to zero is rejected. As expected, the likelihood ratio test [$\chi 2(6) = 20.2105$, $p = 0.0025$)] of the null hypothesis that the covariance of the error terms across equations are not correlated is also rejected. The results of MVP model looked at farmers' adoption of the following improved farm technologies: herbicide use for land preparation, improved maize varieties, planting in lines and maize-legume rotation.

Table 4.4 Maximum Likelihood Estimation Results of the MVP Model.

Variable	Herbicide use for land preparation	Improved maize varieties	Planting in rows	Maize-Legume rotation
	Coefficient	Coefficient	Coefficient	Coefficient
Extension visit	0.1482 (0.0471)***	0.0936 (0.0477)**	0.1278 (0.0481)***	0.0908 (0.0464)**
Land tenure	0.5637 (0.2379)**	-0.2428 (0.2419)	0.1854 (0.2348)	-0.0423 (0.2311)
Memb. of FBO	-0.0534 (0.2219)	-0.4062 (0.2362)*	0.0797 (0.2181)	-0.1381 (0.2208)
Farm size	-0.0051 (0.0376)	0.0520 (0.0369)	0.0697 (0.0373)*	-0.0174 (0.0361)
Household size	0.0150 (0.0170)	-0.0187 (0.0167)	-0.0156 (0.0167)	-0.0290 (0.0162)*
Education	0.2904 (0.2033)	-0.0333 (0.2040)	-0.1275 (0.2063)	-0.1362 (0.2007)
Age	0.0147 (0.0063)**	0.0043 (0.0059)	0.0136 (0.0061)**	0.0104 (0.0059)*
Credit	-0.8885 (0.4210)**	0.8492 (0.4138)**	-0.2053 (0.4071)	0.6458 (0.4001)

Wald $chi^2(32)$ 114.44
Prob > chi^2 0.0000
Log likelihood -745.24252
N 300

Note: standard errors in parenthesis.

*** Significant at 1%, **significant at 5%, *significant at 10% respectively.

Source: Author's estimation from field survey, 2016

Results from the estimation as presented in table 4.4 revealed that extension visit has a positive impact on the adoption of all the four technologies (i.e. herbicide use for land preparation, improved maize varieties, planting in rows and maize-legume rotation). The implication is that as the number of extension visits increases, the probability of adopting these technologies increases. This is consistent with Ajewole (2010), who argues that the frequency of extension visits positively influences the adoption decision of improved farm technologies. The result underscores the important role these technologies play in agriculture and technology adoption decisions in developing countries.

Land tenure influences the likelihood of adoption of herbicide use for land preparation. The implication is that farmers who owned land for cultivation of crops are more likely to adopt herbicide use for land preparation than their tenant counterparts. Consistent with earlier work on technology adoption (e.g., Kassie *et al.*, 2010; Jansen *et al.*, 2006), land tenure influences the adoption of conservation tillage, which is more common on owned plots than on rented plots, possibly reflecting tenure insecurity, suggesting that secure land tenure will encourage adoption decisions. Adoption of herbicide use for land preparation by land owners could be attributed to population growth which necessitates land intensification.

Membership of farmer-based organization (FBO), on the other hand, has a negative and significant influence on the adoption of improved maize varieties. This means that if a farmer belongs to any farmer-based organization, he is less likely to adopt improved maize varieties. This finding is rather surprising as Boughton *et al.,* (2007), reported that farmers who are into groups, are better off in terms of credit access, extension visits, access to fertilizer, improved seeds among others. For instance, it is through the primary cooperative that improved seed distributions are made so that members can easily access seed at reasonable price than the non members. This contradicts with findings of Uaiene *et al.,* (2004), that membership to some association has a positive and significant relationship with both adoption decision and proportion of land area allocated to improved maize.

The results in table 4.4 further underscore the importance of farm size in explaining adoption of planting in rows. The probability of adoption of planting in rows increases when there is an acre increase in farm size. This result is expected giving that planting in rows ensures that plants have adequate planting space which reduces competition for water, light, nutrients etc. which are vital for plants growth and development. This result is consistent with the findings of Feeder *et al.*, (1985), who reported that farm size has a significantly positive correlation with adoption decision due to the fact that it is a proxy for a large number of factors such as size of wealth, access to credit, capacity to bear risk, access to information and other factors.

Household size on the other hand has a negative and significant influence on maize-legume rotation. This implies that when members of a household increase, the likelihood of adopting maize-legume rotation decreases. The results are however consistent with Sain and Martinez, (2004) who states that family size has negative significant relationship with the decision to adopt improved maize. Clearly, the works by Brush *et al.*, (1990) supports the above argument.

The age of the farmer influences the likelihood of adoption of herbicide use for land preparation, planting in lines and maize legume rotation. This means that as the age of the farmer increases, the probability of adopting these technologies also increases. Younger farmers are energetic and can still use the traditional way of land preparation. The aged farmers on the other hand lack the energy and would prefer herbicide use. This is consistent with Sheikh *et al.,* (2000) who found a significant correlation between age and use of summethion pesticide in Uganda among coffee farmers with most adopters being above 50 years. Also, Makokha *et al.*, (1999) reported an increase in the proportion of adopters with age in case of improved bean varieties in Central Uganda while Ramasary et al., (1999) found that age was significantly related to adoption of technologies like maize-legume rotation.

Credit on the other hand, have both negative and positive effects on herbicide use for land preparation and improved maize varieties respectively. This implies that access to credit will decrease the probability of adopting herbicide use for land preparation and increase that of improved maize varieties. Access to credit was hypothesized to influence adoption decisions positively. Credit availability is an important factor in adoption of agricultural technologies. Access to credit by the farmers is expected to ease liquidity constraint and enable them to finance or purchase external inputs such as improved maize varieties. Consistent with this finding is the one conducted by Judicate *et al.,* (1998) who found access to credit to be positively significant in explaining adoption of improved wheat varieties in Tanzania. Meanwhile, Uaiene *et al.* (2009) and Zavale *et al.* (2005), who analyzed agricultural technologies adoption in Mozambique, using TIA 2002 and 2005 data, reported a negative correlation between access to credit and adoption. In addition, Ruttan and Thirtle (1987) identified credit as a major factor affecting adoption of new hybrid rice technologies in Thailand. Bhalla (1979) and Feder *et al.* (1985) had similar findings.

4.4 Poisson model with endogenous treatment

After looking at factors influencing the adoption of IFTs, effect of contract farming participation on the adoption of IFTs is now discussed. This objective seeks to determine the effect of contract farming on the adoption of improved farm technologies (IFTs). As a result of a possible sample selection problem, there was an initial estimation of a selection (contract farming) and substantive equations (adoption of IFTs) to correct for such selection problem. The Wald test of independent equations shows a chi square probability of 0.0209. This means that selectivity bias problem is present in the model. This calls for the estimation of two equations for contract farming and adoption of IFTs.

Table 4.5 shows the results from a Poisson estimation that indicates the factors influencing the adoption of IFTs. The Poisson model is estimated using the maximum likelihood method. The goodness of fit parameter of the model indicates that the model adequately predicted the determinants of adoption of IFTs. The chi-squared value was significant at 1%, implying that all the variables jointly determined the dependent variable. The Wald test of independent equations shows a chi square probability of 0.0209. The null hypothesis that there is no correlation between the treatment errors and the outcome errors is rejected.

The results indicate that age, credit, extension visit and contract had positive effect on adoption of IFTs. However, education and experience had negative influence on the adoption of IFTs. Meanwhile, in the previous model (i.e. MVP model), the results also show that extension visit, land tenure, credit and farm size had positive influence on the adoption of IFTs while membership of FBO and household size had negative influence on IFTs adoption.

Age was positive and significant at 5% level of significance. This implies that as the age of the farmer increases, they will turn to adopt more of IFTs. In other words, older farmers are more likely to adopt IFTs than their younger counterparts. This could be attributed to the fact that older farmers have more resources compared to young farmers since they have worked for long and have accumulated enough resources. Therefore, older farmers could have more access and ability to purchase agricultural technologies and are more likely to adopt agricultural technologies. High resource base for older farmers would make them less risk averse as they have the capacity to cope with risk associated with use of technology. Studies by Wanyoike *et al.*, (2000) and Adesina and Zinnah (1993) have shown that age influences adoption decision positively.

Table 4.5: Maximum likelihood estimation of factors influencing adoption of IFTs

Variable	Coefficient	Standard Error	Z-Value	P-Value
Constant	0.1951	0.1348	1.45	0.148
Age	0.0060**	0.0029	2.05	0.041
Education	-0.0302	0.1081	-0.28	0.780
Credit	0.1226	0.1715	0.71	0.475
Extension visit	0.0734***	0.0246	2.98	0.003
Experience	-0.0079	0.0049	-1.63	0.103
Contract	0.2598*	0.1418	1.83	0.067

LR $chi^2(6)$ 45.54

Prob > chi^2 0.0000

Log likelihood -599.51902

N 300

Wald test of ind. Eqns. (rho=0): chi^2 (1) 5.33

Prob > chi^2 of ind. eqns. 0.0202

Note: *** Significant at 1%, **significant at 5%, *significant at 10% respectively

Source: Author's estimation from field survey, 2016

Extension contact was positive and significant at 1% level of significance. This implies that farmers who have access to extension services are more likely to adopt IFTs than farmers who have no access to extension service. The reason could be that access to extension services are the means through which agricultural technologies are transferred from researchers to farmers. Therefore, access to extension services facilitates the up-take of technology. Studies by Adesina and Zinnah (1993), Nkonya *et al.,* (1997), Judicate *et al.*, (1998), Wanyoike *et al.*, (2000) and Sall *et al.*, (2000) among others have shown access to extension services to be a very important factor in adoption decisions.

Farmers who had contact with extension officers have 7% greater probability of adoption.

Contract farming was positive and had 10% significant levels. This means that farmers who are into contract farming are more likely to adopt IFTs than farmers who are not under contract farming. Contract farmers have greater access to credit, education and sensitization from their contractors, compared with the non-contracting farmers. Again, contract farming affords the farmers the opportunity to use modern inputs and other production methods, which in most cases form part of the contractual agreement. The use of such improved methods enhances farmer flexibility or resilience to adaptation (Shrestha, 2014). This is consistent with Foltz (2003) hypothesis that, farmers who have better access to credit stand a better chance of adopting a technology faster than those who are capital-constrained. Ekboir *et al.* (2002) and Simtowe and Zeller (2006) had similar findings in their respective studies.

4.5 Factors influencing the participation of farmers in contract farming (CF)

This section deals with the factors that influence farmers' participation in contract farming, having looked at effect of contract farming participation on the adoption of IFTs in the previous section. Using the selected variables, a statistical test of a relationship between the dependent (contract farming) variable and the covariates were carried out. The null hypothesis that there was no significant difference between the dependent variable and the covariates were tested. From the test results, the probability of the model chi-square was found to be 0.0000. This means the model was significant at 1%. The null hypothesis that there was no significant difference between the dependent variable and the covariates were rejected. The existence of a relationship between the dependent variable and the covariates were therefore confirmed. The marginal effects of factors that influence the participation in contract farming are therefore presented.

4.5.1 Marginal Effects of Factors Influencing the Participation in CF

Table 4.6 below shows the effects that the socioeconomic factors have on the participation in contract farming. The coefficients of the probit regression only show the direction of the effects that an explanatory variable has on the dependent variable. Therefore, the marginal effects which show the magnitude of the changes that occur in the dependent variable when there are corresponding changes in the independent variables were also estimated.

The education of the farmer had a positive influence in the participation in CF. The marginal effect indicates that when a farmer is a literate, the probability of taking part in contract farming is 17% greater than their illiterate counterparts. Education increased the probability of contract farming participation in the study area. Educated farmers are more analytical and observe easily the obvious advantages of contract farming participation. The positively significant influence implies that the higher the level of formal education, the higher the probability of participating in contract farming. This confirms the work of Abbey and Admassie (2004); Doss and Morris (2001); and Foltz (2001) who argue that, farmers who have better education and are able to read and understand information about the technology tend to have a greater probability of adoption than their illiterate counterparts.

Table 4.6: Probit regression results of factors influencing participation of CF

Variable	Coefficient	Standard Error	dy/dx (Marginal Effect)	Standard Error
Age	0.0095	0.0075	0.0038	0.0030
Education	0.4217*	0.2325	0.1661*	0.0903
Land tenure	-0.3968	0.3162	-0.1558	0.1223
Memb. of FBO	-0.2171	0.2724	-0.0858	0.1071
Dist. to market	-0.0127	0.0180	-0.0050	0.0072
Farm size	0.0398	0.0461	0.0158	0.0183
Size of parcel	-0.0045	0.0217	-0.0018	0.0086
Sex	0.3981*	0.2388	0.1573*	0.0934
Risk	0.3705*	0.2107	0.1462*	0.0823
Credit	1.2990***	0.4927	0.4840***	0.1593
Interest rate	0.4829**	0.2134	0.1899**	0.0824
Experience	-0.0130	0.0123	-0.0052	0.0049
Constant	-1.4117***	0.2967		
LR $chi^2(12)$ 164.01				
Prob > chi^2 0.0000				
Pseudo R^2 0.3954				
Log likelihood -125.39936				
N 300				

Note: ***significant at 1%, **significant at 5%, *significant at 10%

Source: Author's estimation from field survey, 2016

Also, access to credit, was significant at 1% level of significance. The positive significance of the marginal effect indicates that when a farmer had access to credit, the probability of him taking part in CF is 48% greater than those who do not have access to credit. Credit is an important source of capital which facilitated the participation in CF. This is consistent with Foltz's (2003) hypothesis that, farmers who have better access to credit stand a better chance of taking part in CF than those who are capital-constrained. Ekboir *et al.*, (2002) and Simtowe and Zeller (2006) had similar findings.

Sex of the respondent was significant at 10% level of significance with a marginal effect of 0.1573. This means that the probability of a male farmer taking part in contract farming is greater than a female farmer by about 16%. Primarily, male farmers are the decision makers and as such control most resources at farm level, leaving female farmers to take a supportive role.

Attitude towards risk which indicates whether a farmer is an early adopter or late adopter in this study was significant at 10% level of significance with a marginal effect of 0.1462. The positive significance of the marginal effect indicates that early adopters have 15% greater probability of participating in contract farming than late adopters. This is not surprising because early adopters will always explore the available chance to rip its benefit.

Furthermore, the marginal effect of the interest rate was positive and significant at 5% level of significance. This variable is a dummy with zero (0) if the interest rate is perceived by the farmer to be high and one (1) if it is perceived to be low. The positive significance of the variable indicates that the farmers who perceived that the interest rate was low had a 19% higher probability of participating in contract farming than those who perceived it to be high. This means that lower interest rates makes the cost of borrowing cheaper. This will motivate farmers to participate in CF to reap its benefits.

4.6 Constraints faced by maize farmers

Table 4.7 shows constraints in maize production. The results show that the biggest constraint in maize production was high cost of inputs. This constraint recorded the least mean rank score (2.02) and of course, the most pressing problem among maize farmers in the study area. This is not surprising, as cost of maize inputs (seeds, herbicides and fertilizers) to carry out farm operations was very high beyond the reach of these poor farmers. This confirms the work of Hussan *et al.,* (2003) who reported that high cost of input is a major challenge among maize farmer.

The constraint which came second was lack of access to credit. This constraint recorded a mean rank score of 2.48. Majority of the farmers are small-holder farmers and are capital constrained, as most of them depend on their relatives for money to carry out their farm operations. This normally has some effects on the type of input used by the farmer as well as the appropriateness and timing of farming operations. This finding is consistent with Thomson *et al.,* (2014) who reported that access to credit hindered most farmers in maize production.

Lack of improved seeds was their third most pressing issue. The mean rank score for this constraint was 3.15. This was plausible because, improved seeds are really costly. Looking at the situation of farmers in the study area who depend on friends, relatives and contractors for financial support to carry out their farm operations, buying improved seeds would be a very big challenge to them. This is in line with the findings of Feleke and Zegeye (2005) who reported that one of the serious problems facing maize farmers is lack of improved seeds.

Table 4.7 Constraints faced by farmers in maize production

Constraints	Mean rank	Rank
Lack of improved seeds	3.15	3
Lack of access to tractor	6.02	6
High cost of inputs	2.02	1
Lack of weather info. for planting	4.25	4
Low yield	6.70	8
Lack of access to credit	2.48	2
Low soil fertility	6.39	7
Drought	4.99	5
N 300		
Kendall's W[a] 0.550		
Chi^2 1155.269		
Df 7		
Asymp.Sig 0.000		

Source: Author's estimation from field survey, 2016

Next to this was lack of weather information for planting. This constraint had a mean score of 4.25. This could be true, looking at the current state of extension officers in the country who are in charge of passing on information related to agriculture to farmer. MoFA (2012) reported that the present extension-farmer ratio in Ghana is 1:1500. This could really be a challenge if one (1) extension officer is to look after 1500 farmers. Consistent with this finding is the work of Paudel and Matsuoka (2008) who reported that lack of weather information for planting is a major setback for most farmers especially those into maize cultivation.

The fifth constraint was drought which had 4.99 as the mean rank score. These results were not surprising because farmers in the study area have been experiencing unreliable rainfall pattern and drought is very common. The rainfall pattern has been erratic or unpredictable. This finding confirms the work of SARI (2006) that drought has a devastating effect on farmers and poses a serious challenge to maize farmers.

Lack of access to tractor was the sixth constraint. This constraint recorded a mean rank score of 6.02. The cause of this is that majority of the farmers do not own farm tractors and have to resort to hiring from business people or large-scale farmers. The consequence is that farmers do not carry out their farm operations in time. Also, the farmers sometimes experience shoddy work on their farm by the tractor operators and this result in reduction in yield. Timely operation depends on ownership or access to tractors. So they suffer greatly in delay farming due to lack of tractors at their disposal. Consistent with this is the work of Kabali et al., (2000) who reported that lack of access to tractor delays farmers in their farming operations.

The seventh constraint was low soil fertility with a mean rank score of 6.39. This could be attributed to the fact that they have been farming in their plots for a very long time leading to the depletion of both minor and major nutrients needed for plant growth and development. This finding is in line with FAO (2005) report, that one of the problems facing farmers is low level of soil fertility.

The last constraint was low yield. This recorded a mean rank score of 6.70. This is attributable to the soil fertility of their farm lands. The depletion of the soil nutrients, coupled with farmers' inability to buy fertilizer will lead to low yield. This finding is in agreement with MOFA (2011) report that most farmers are poor because they record low yield on their farms.

The results from the table above show that there is an agreement among the ranking and it is very high, since the Kendall's coefficient (W) is 0.550 or 55%. This was also asymptotically significant at 1% and had a Chi-Square value of 1155.269. Hence we reject the null hypothesis, which states that there is no agreement amongst the rankings

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND POLICY RECOMMENDATIONS

5.0 Introduction

This chapter summarises the main findings of the study and draws major conclusions stemming from the results and analysis of the study. Based on the major findings of the study, policy recommendations are also made for future interventions in the production of maize.

5.1 Summary of findings

The study examined contract farming and adoption of improved technologies in maize production in the Northern region of Ghana. The objectives were to: identify the improved farm technologies (IFTs) being adopted in the study area and measure the extent of adoption; examine the factors influencing the adoption of IFTs; examine the factors influencing the adoption of improved farm technologies (IFTs); assess how participation in contract farming (CF) affect adoption of IFTs; investigate the factors influencing participation in CF as well as the problems faced by maize farmers. A sample size of 300 was used. The objectives of the study were analysed using Multivariate probit (MVP) model, Poisson model with endogenous treatment, Probit model and Kendall's coefficient (W). The MVP was used to respectively examine the factors influencing adoption of IFTs while poisson model with endogenous treatment was used to holistically examine the effect of contract farming on adoption of IFTs. The Probit model was used to generally assess the factors influencing the participation in CF while the Kendall's coefficient of concordance was used to analyse the constraints faced by maize farmers in the study area.

The following were the key findings that emerged from the study.

1. Maize farmers adopted all the IFTs as follows: herbicide use for land preparation (25.84%); improved maize varieties (25.55%); row planting (23.94%) and maize-legume rotation (24.67%).
2. The MVP results show that extension visit, land tenure and age of farmer had positive influence on the adoption of herbicide use for land preparation. However, credit was found to have negative influence on the adoption of herbicide use for land preparation. Also, extension visits and credit positively influenced the adoption of improved varieties, while membership of FBO negatively affected adoption of improved varieties. Furthermore, extension visits, farm size and age had positive effect on the adoption of planting in rows. Lastly, while extension visits and age had positive influence on maize-legume rotation, household size had negative influence on maize-legume rotation.
3. The poisson model with endogenous treatment results show that age, extension visits and participation in contract positively influenced adoption of IFTs. Awareness, farm size and sex also determined participation in contract farming.
4. The probit model results show that education, sex, attitude towards risk, access to credit and perception about the interest rate all had positive influence on participation in contract farming.
5. The most pressing constraint associated with maize farmers in the study area was high cost of inputs. This was followed by lack of access to credit, with low yield recorded as the least pressing constraint.

5.2 Conclusions

Based on the findings, the following conclusions can be drawn.

1. Participation in contract farming as well as extension visits and favourable land tenure arrangements play a key role in the adoption of IFTs.
2. Education, sex, attitude towards risk, credit and perception about interest rate are important in increasing participating in CF.
3. Of all the constraints faced by farmers in the study area, high cost of inputs was their biggest problem.

5.3 Policy Recommendations

Based on the conclusions of this study, the following recommendations are made.

1. Government should train and support more extension officers in the country to help in the education of farmers on the importance of IFTs. Once they are trained and equipped extension officers should be diligent in discharging their duties.
2. Private institutions and NGOs should be lobbied and encouraged to go into contract farming with the farmers.
3. Government should provide quality education and also make it accessible in the study area.
4. Government should subsidize inputs (fertilizers, herbicides, insecticides etc.) and put on measures to ensure that the inputs get to the targeted farmers.

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APPENDICES

APPENDIX 1: Probit model to examine the factors that influence participation in contract farming

```
Probit regression                               Number of obs   =        300
                                                LR chi2(12)     =     164.01
                                                Prob > chi2     =     0.0000
Log likelihood = -125.39936                     Pseudo R2       =     0.3954
```

cf	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
age	.0095166	.0074757	1.27	0.203	-.0051355	.0241688
educ	.4217086	.2324523	1.81	0.070	-.0338895	.8773066
l_tenure	-.3967835	.3162316	-1.25	0.210	-1.016586	.2230191
mfbo	-.2171379	.2723585	-0.80	0.425	-.7509509	.316675
d_mkt	-.0127272	.0180472	-0.71	0.481	-.048099	.0226446
f_size	.0397603	.0461061	0.86	0.388	-.0506059	.1301265
sizpcl	-.0044647	.0216756	-0.21	0.837	-.0469482	.0380187
sex	.3981301	.2388031	1.67	0.095	-.0699153	.8661756
risk	.3705285	.210682	1.76	0.079	-.0424007	.7834576
credit	1.299041	.4926611	2.64	0.008	.3334434	2.264639
i_rate	.4828928	.2133548	2.26	0.024	.064725	.9010606
exp	-.0129977	.0122572	-1.06	0.289	-.0370214	.0110259
_cons	-1.411655	.2966894	-4.76	0.000	-1.993155	-.8301543

APPENDIX 2: Marginal effects after probit

```
Marginal effects after probit
      y  = Pr(cf) (predict)
         =  .54570516
```

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
age	.0037716	.00296	1.27	0.203	-.002034	.009577	43.7367
educ*	.1661425	.09031	1.84	0.066	-.01087	.343155	.53
l_tenure*	-.155833	.12225	-1.27	0.202	-.395438	.083771	.553333
mfbo*	-.0858165	.1071	-0.80	0.423	-.295724	.124091	.533333
d_mkt	-.005044	.00715	-0.71	0.481	-.019064	.008976	6.77867
f_size	.0157579	.01827	0.86	0.388	-.020057	.051572	4.91667
sizpcl	-.0017695	.00859	-0.21	0.837	-.018606	.015067	4.14
sex*	.1573032	.09339	1.68	0.092	-.025729	.340336	.59
risk*	.1462174	.0823	1.78	0.076	-.015094	.307529	.533333
credit*	.4839891	.15927	3.04	0.002	.171825	.796153	.583333
i_rate*	.1898514	.08237	2.30	0.021	.028411	.351292	.53
exp	-.0051513	.00486	-1.06	0.289	-.014668	.004366	24.2233

(*) dy/dx is for discrete change of dummy variable from 0 to 1

APPENDIX 3: Poisson model with endogenous treatment to estimate the effect of contract farm participation on the adoption of improved farm technologies

```
Poisson regression with endogenous treatment    Number of obs     =        300
(24 quadrature points)                          Wald chi2(6)      =      45.54
Log likelihood = -599.51902                     Prob > chi2       =     0.0000
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
total						
age	.0059503	.0029063	2.05	0.041	.000254	.0116465
educ	-.0302403	.1081072	-0.28	0.780	-.2421265	.181646
credit	.1225637	.1714554	0.71	0.475	-.2134827	.4586101
ex_visit	.073384	.0246387	2.98	0.003	.025093	.1216751
exp	-.007945	.0048751	-1.63	0.103	-.0175	.0016101
1.cf	.2598404	.1417815	1.83	0.067	-.0180462	.537727
_cons	.1950646	.1347564	1.45	0.148	-.0690531	.4591822
cf						
l_tenure	.0647523	.2229048	0.29	0.771	-.3721331	.5016376
mfbo	.2653883	.2068686	1.28	0.200	-.1400667	.6708434
awareness	.9942217	.2257553	4.40	0.000	.5517494	1.436694
d_mkt	-.0100231	.0167352	-0.60	0.549	-.0428234	.0227773
f_size	.0765044	.043058	1.78	0.076	-.0078877	.1608966
sizpcl	.0120474	.0201984	0.60	0.551	-.0275407	.0516354
sex	.600596	.2246211	2.67	0.007	.1603468	1.040845
_cons	-1.362625	.2381794	-5.72	0.000	-1.829448	-.8958021
/athrho	-1.850883	.8014615	-2.31	0.021	-3.421719	-.2800478
/lnsigma	-2.652798	.8648766	-3.07	0.002	-4.347925	-.9576714
rho	-.9518291	.0753545			-.9978694	-.2729493
sigma	.0704538	.0609338			.0129336	.3837855

```
Wald test of indep. eqns. (rho = 0): chi2(1) =     5.33   Prob > chi2 = 0.0209
```

APPENDIX 4: Multivariate probit model to examine factors that influence adoption of improved farm technologies

```
Multivariate probit (SML, # draws = 5)          Number of obs   =        300
                                                Wald chi2(32)   =     114.44
Log likelihood = -745.24252                     Prob > chi2     =     0.0000
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
tech_1						
ex_visit	.1481564	.0471079	3.15	0.002	.0558265	.2404862
l_tenure	.5637027	.2379431	2.37	0.018	.0973428	1.030063
mfbo	-.0534079	.221868	-0.24	0.810	-.4882611	.3814454
f_size	-.0051472	.0375651	-0.14	0.891	-.0787735	.0684791
hhs	.0149533	.0170383	0.88	0.380	-.0184411	.0483478
educ	.2903965	.2032973	1.43	0.153	-.1080589	.6888519
age	.0146732	.0062795	2.34	0.019	.0023657	.0269807
credit	-.888522	.4210376	-2.11	0.035	-1.713741	-.0633035
_cons	-1.147224	.2761685	-4.15	0.000	-1.688504	-.6059437
tech_2						
ex_visit	.0936167	.047661	1.96	0.050	.0002027	.1870306
l_tenure	-.2428482	.2419381	-1.00	0.315	-.717038	.2313417
mfbo	-.4062443	.2361698	-1.72	0.085	-.8691287	.0566401
f_size	.0519831	.0369396	1.41	0.159	-.0204171	.1243834
hhs	-.0187046	.0166678	-1.12	0.262	-.0513728	.0139636
educ	-.0332983	.2040029	-0.16	0.870	-.4331366	.3665401
age	.0043119	.0059298	0.73	0.467	-.0073103	.015934
credit	.8492416	.4138177	2.05	0.040	.0381738	1.660309
_cons	-.5390813	.2592753	-2.08	0.038	-1.047252	-.0309112
tech_3						
ex_visit	.127796	.0481182	2.66	0.008	.0334859	.222106
l_tenure	.1853919	.2348397	0.79	0.430	-.2748854	.6456693
mfbo	.0797246	.2181462	0.37	0.715	-.3478342	.5072833
f_size	.0696826	.0372815	1.87	0.062	-.0033879	.1427531
hhs	-.0156444	.0166782	-0.94	0.348	-.048333	.0170443
educ	-.1274883	.2062788	-0.62	0.537	-.5317873	.2768108
age	.0136353	.0060502	2.25	0.024	.0017771	.0254935
credit	-.205303	.4071025	-0.50	0.614	-1.003209	.5926032
_cons	-1.160682	.2746969	-4.23	0.000	-1.699078	-.6222859
tech_4						
ex_visit	.0907634	.0464454	1.95	0.051	-.0002678	.1817946
l_tenure	-.042164	.2310854	-0.18	0.855	-.495083	.4107551
mfbo	-.1381167	.2208354	-0.63	0.532	-.570946	.2947127
f_size	-.0173542	.0361323	-0.48	0.631	-.0881722	.0534638
hhs	-.0290091	.0161857	-1.79	0.073	-.0607325	.0027144
educ	-.136231	.2006625	-0.68	0.497	-.5295223	.2570603
age	.010446	.0059082	1.77	0.077	-.0011339	.0220259
credit	.6457997	.4000742	1.61	0.106	-.1383314	1.429931
_cons	-.4565965	.2590221	-1.76	0.078	-.9642705	.0510776

/atrho21	.2403171	.0966913	2.49	0.013	.0508056	.4298285
/atrho31	.0679825	.0938328	0.72	0.469	-.1159265	.2518914
/atrho41	-.2976528	.0982719	-3.03	0.002	-.4902622	-.1050435
/atrho32	.1295458	.0966166	1.34	0.180	-.0598193	.3189109
/atrho42	-.0311082	.0945459	-0.33	0.742	-.2164148	.1541984
/atrho43	.1220317	.0869452	1.40	0.160	-.0483777	.2924411
rho21	.2357952	.0913153	2.58	0.010	.0507619	.405178
rho31	.0678779	.0934005	0.73	0.467	-.11541	.2466958
rho41	-.2891632	.0900549	-3.21	0.001	-.4544245	-.1046588
rho32	.128826	.0950132	1.36	0.175	-.0597481	.3085218
rho42	-.0310982	.0944545	-0.33	0.742	-.2130983	.1529877
rho43	.1214295	.0856631	1.42	0.156	-.04834	.28438

Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0:
chi2(6) = 20.2105 Prob > chi2 = 0.0025

APPENDIX 5: Questionnaire

UNIVERSITY FOR DEVELOPMENT STUDIES

Department of Agricultural and Resource Economics

MPhil (Agricultural Economics)

CONTRACT FARMING AND ADOPTION OF IMPROVED TECHNOLOGIES IN MAIZE PRODUCTION IN THE NORTHERN REGION OF GHANA

This questionnaire is meant for data to address the above topic in partial fulfillment for the award of Master of Philosophy Degree in Agricultural Economics at the University for Development Studies. Your respond to the questions would encourage the researcher to get appropriate findings that will contribute to knowledge in the academia. Your confidentiality is assured.

District……………………………..….

Town……………………………………..

Interviewer……………………………….. Date.…/.…/.…

1. Name of respondent……………………………………………………

2. Gender 1 = Male [ ] 2 = Female [ ]

3. Age of respondent …..…………..

4. Household size…………………….

5. Any other dependants that are not household head's children or spouse? ………………

6. Household head's major occupation.

1). Farming 2) Business 3) Civil servant 4) Unemployed 5) Others (specify)……

7. Who make decisions on the type of technologies to be adopted on this farm?

1) Husband…… 2) Wife ……….

8. Marital Status 1=Single [ ] 2=Married [ ] 3=Divorced/Separated [ ] 4 = Widowed [ ]

9. Level of Education Attained 0 = No Formal Education [ ] 1 = Primary [ ] 2 = JHS [ ] 3 = SSS/WASSCE [ ] 4 = Vocational [ ] 5 = polytechnic level [ ] 6 = University (bachelor) Level [ ] 10 = University (Graduate or Above) Level [ ]

11. Land own: 1=Owner (eg. family, purchase) [ ] 2 = Otherwise (eg. lease, rent, contract,) []

12. Total farm size……………acres

13. How long have you been farming maize? ………………years.

14. What distance do you travel to the market?

1) < 5 Km 2) 5 – 10 Km 3) > 10 Km

15. Did you use hired labour during the 2015-cropping season? 1 Yes 0 No

If yes,

(i) How many permanent laborers did you have?

(ii) How many casual .... and for how many mandays?

16. What is your response to a new technology? a) early adopter b) late adopter c) other …….

17. Would you take a loan at an interest rate of 5% and/or above? a) Yes [ ] b) No [ ]

18. Kindly indicate your knowledge and use of improved farm technology

Type of improved technology	**Awareness**		**Utilizing on farm**	
	Yes	No	Yes	No
Herbicide use for land preparation				
Improved varieties				
Row planting				
Maize-Legume rotation				

19. How long, since you first heard about improved farm technologies? ....Years

20. Whom/where did you first hear about the improved farm technologies? ………

21. How many times have you purchased improved maize seeds since you started using it? ……………………times.

22. From where do you usually get improved maize seeds? ....

23. Can/do you purchase the amount you need to plant? 1= Yes [ ] 2 = No [ ]

24. If no, why? i) not available …… ii) too expensive……… iii) cash shortage ………

iv) was not sure of benefit …. v) not available on time …. vi) not better than local ………

25. Are you cultivating both traditional and improved varieties? 1= Yes [ ] 2 = No [ ]

26. Do you have access to credit in the production and maintaining of your farm? 1= Yes [ ] 2 = No [ ]

27. Are you a member of any farmer-based organization in your District/Region? 1= Yes [ ] 2 = No [ ]

28. If yes, provide the name...

29. What are the contributions of the organization to your production?

....

30. Source of extension services1= Government [ ] 2 = NGO [ ] 3 = Others ……………...

31. What type of extension services to you get ……….

i) weed control ii) during input/tools provision iii) during nursery iv) whenever disease/

pest occur v) using transplanting vi) during credit collection vii) others

(Specify)………………………………………………

32. How many times do the extension agents visit you? ....

33. Do you visit/invite extension agent? 1= Yes [ ] 2 = No [ ]

34. If yes, when do you visit/invite? ………………………

i) During sowing ii) Weed control iii) during fertilizer application iv) whenever disease/ pest occur v) others (Specify)…………..……………………………….

35. Are you under any contract? …………………………….

36. If yes to 32, what contract are you in? a) input contract b) output contract c) others……

37. Do you have any position in your society? A) yes [ ] b) No [ ]

38. What constraints did you face in maize production during the 2015-cropping season?

1. Lack of improves seeds

2. Lack of access to tractor

3. High cost of inputs

4. Lack of weather information for planting

5. Low yield

6. Lack of access to credit

7. Low soil fertility

8. Drought

Thank you