

**UNIVERSITY FOR DEVELOPMENT STUDIES**

**IRRIGATION AND HOUSEHOLD FOOD SECURITY AMONG FARMING  
HOUSEHOLDS: EVIDENCE FROM VEA IRRIGATION IN THE BONGO  
DISTRICT OF THE UPPER EAST REGION IN GHANA**

**IBRAHIM WAHAB**

**2016**



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DISTRICT OF THE UPPER EAST REGION IN GHANA**

**BY**

**IBRAHIM WAHAB (B.A. Integrated Development Studies)**

**UDS/MDS/0265/12**

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MASTER OF PHILOSOPHY DEGREE IN DEVELOPMENT STUDIES**

**2015**



## DECLARATION

### Candidate's 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.

Candidate's Signature: .....

Date .....

Candidate's Name: Ibrahim Wahab

### Supervisors' Declaration:

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

Principal Supervisor's Signature:.....

Date.....

Principal Supervisor: Dr. Frank K. Teng-Zeng

Co-Supervisor's Signature.....

Date.....

Co-Supervisor: Mr. Anthony Chiaraah



## ABSTRACT

This thesis examined the food security status of farming households in the catchment communities of the Veia irrigation Dam in the Bongo District of the Upper East Region of Ghana. Particularly the study examined the influence of household heads' participation in irrigation farming on household food security status. A multistage sampling technique was used to select the respondents. Households were selected from four communities namely, Veia, Bongo Nyariga, Gowrie, and Zaare. A total of 160 households responded to the survey. However, due to incomplete or inconsistent data, 12 households were disregarded. The remaining 148 farming households were included for the data analysis. Structured interview schedule was used as the main data collection instrument. Food consumption data of the 148 households were used for the analysis of food security. The study reveals that (45.3%) of the farming household were found to be food secured. Whereas only 65.2% of irrigation farming households were food secured, 27.8% of non-irrigation farming households were food secured. Further, the logit model revealed that household size, donkey ownership, participation in non-farm activities, access to irrigation and credit service were significant determinants of household food security status. From the perspectives of the household heads that, erratic rainfall pattern, lack of income generating alternatives are some constraints to household food security situation in the area. The study therefore recommends that, farmers within the catchment area of irrigation should be encouraged to patronise irrigation so as to boost the production capacities of farming households to help alleviate poverty and address food insecurity.



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## DEDICATION

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## LIST OF ACRONYMS OR ABBREVIATIONS

AU	African Union
CAADP	Comprehensive Africa Agricultural Development Programme
CFS	Committee on World Food Security
CHS	Cardiovascular Health Study
CSAE	Centre for Studies of African Economies
DCI	Daily Calorie Intake
DERF	Dynamical Extended Range Forecast Product
FAO	Food and Agriculture Organisation
FAOSTAT	Food and Agriculture Organization Statistical Databases
FBO's	Farmer Based Organizations
FSCO	Food Security Coordination Office
FSI	Food Security Index
GH	Ghana
GIDA	Ghana Irrigation Development Authority
GoG	Government of Ghana
GPRS	Ghana Poverty Reduction Strategy
GSS	Ghana Statistical Service
ICOUR	Irrigation Company of Upper East Region
ICRA	International Center for Relativistic Astrophysics
IDA	Irrigation Development Authority
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute





IPTRID	International Programme for Technology and Research in Irrigation and Drainage
IUCN	Inter- national Union for Conservation on nature and Natural resources
IWMI	International Water Management Institute
KIPPRA	Kenya Institute for Public Policy Research Analysis
LEAP	Livelihood Empowerment Against Poverty
MASLOC	Microfinance and Small Loans Center
MDGs	Millennium Development Goals
MOFA	Ministry of Food and Agriculture
NEPAD	New Partnership for African Development
RDCR	Recommended Daily Calorie Required
RDCRA	Recommended Daily Calorie Required Approach
SADC	Southern African Development Countries
SFIP	Small Farms Irrigation Project
SNNP	Southern Nation and Nationalities People
SPSS	Statistical Product for Service Solutions
SSIDP	Small Scale Irrigation Development Project
STATA	Statistical Data
UNICEF	United Nation Children’s Fund
USD	United State Dollar
VIF	Variance Inflation Factor
WFP	World Food Program



WHO World Health Organisation

**LIST OF UNITS**

G	Gram
Ha	Hectare
Kcal	Kilo calorie
Kg	Kilo gram
Km	Kilometer





## CHAPTER ONE

### INTRODUCTION

#### 1.0 Background of the study

Food insecurity is one of the most pervasive challenges to global sustainable development pursuit. Global food shortages and economic crisis coupled with climate variability has catapulted the problems and consequences of food insecurity among the vulnerable and the poor most especially in developing countries. Again, the rapid growth of the world's population puts great pressure on critical resources such as water, energy and food. The system of food production and distribution is expected to meet the challenge of ensuring food security while at the same time dealing with the current impact of climate change on agriculture and adapting agriculture to lessen its future environmental impact (FAO, 2010).

The challenge of food insecurity at the global level is caused by a number of factors including disparities in consumption and production of cereals; lack of access to food grains; and logistical and financial constraints in the transportation and distribution of food grains to deficit areas, lack of asset endowment, off farm income, and area under cultivation. Besides, longer-term dynamics such as climate change and mounting food demand through changing dietary patterns and growing populations have strained international food markets and are expected to lead to further rising food prices and increasing price volatility (Nelson *et al.*, 2010; FAO, 2011).



Food is vital for any living being. As a result, when and where it is scarce, it provides power for those who control it and the resources required for producing food. The perceived or actual shortage of food, or the need for resources for producing food, has been a driver of migrations for entire populations and has been at the root of many political conflicts (Arene and Anyaeji 2010). The two most essential elements of food security are the availability of food, and the ability to acquire it. Food security therefore is not just the physical availability of any single commodity but must be accessible in terms of affordability in adequate quantities, containing essential nutrients. (FAO, 2011).

Despite considerable efforts of national governments and the international community to reduce hunger and malnutrition in the context of the Millennium Development Goals (MDGs) and other initiatives, the proportion of undernourished people in developing countries has been largely constant since the mid- 1990s (FAO, 2010). While some progress in hunger reduction had been made until 2007, the 2008 global food price crisis and subsequent food price spikes in local markets have pushed or kept millions of people in food insecurity (Brinkman *et al.*, 2010; FAO 2009).

Food insecurity remains a major development issue for Africa, with many countries facing periodic food problems. One of the biggest challenges predicted to affect food security in Africa is climate change. Due to the fact that 95 percent of Africa's agriculture is rainfed, the already fragile agricultural sector is extremely vulnerable



to climate change. Higher temperatures and an increased frequency of extreme weather events, such as droughts and floods, eventually lead to a decline in agricultural output. The ability of African states to reduce vulnerability and strengthen the resilience of their agricultural sectors appears to be hampered. Major factors contributing to this are humanitarian crises caused, inter alia, by droughts and other natural calamities, wars and displacement of populations, lack of inputs, poor agricultural practices, high international prices and an overdependence on imported food stuffs, etc. It is important, therefore, that food security remains high on the continent's development agenda (Antonie, 2011). Irrigated agriculture remains the biggest solution to Africa's food insecurity crises.

In Ghana, the highest incidence of food insecurity is found in the dry savannah areas, comprising the Upper East, Upper West and Northern Regions. While food insecurity rates hover around one to seven percent in southern Ghana, rates are between 10-30 percent in the north (Biederlack and Rivers, 2009: 13). Paradoxically, households producing food crops are sometimes casualties of food insecurity in northern Ghana (Biederlack and Rivers, 2009).

The incidence of food insecurity, however, is not a new phenomenon in these regions. A close examination of the historical literature demonstrates that hunger featured prominently in early colonial narratives, with reports showing poor harvests and famine in the northern territories of the Gold Coast now northern Ghana (National Archives of Ghana, 1911; 1939). Early anthropological research also



reported widespread malnutrition and undernourishment in northern Ghana throughout the late colonial period (Cardinal, 1921: 85; Hart, 1978: 194-209). Since the magnitude of food insecurity in the northern regions has been recorded since colonial times, awareness of the problem and policy attempts to remedy it.

It is therefore imperative for the involvement of governments across the globe in incorporating irrigation development plan into their national agenda. Consequently attention should be focused by policymakers on the development of dams for the purpose of irrigation to augment the erratic nature of rainfall. Irrigation has long played a key role in feeding expanding populations and is undoubtedly destined to play a still greater role in the future (FAO, 1997).

Irrigation development in Ghana is critically important in ensuring that the nation attains a reliable and sustainable crop production and productivity as a move towards food security and poverty reduction. The growth in agriculture in Ghana has remained unpredictable and of low productivity, this being due to the utter dependence on rainfall which is erratic, unreliable and non-uniformly distributed. This dependence on rainfed agriculture has left the country tremendously vulnerable to the vagaries of weather (Namara et al 2011).

It is widely accepted that, the currently increasing global warming and climate change, is having negative effects on the optimal availability of water resources for



crop production worldwide including Ghana. In this regard, Ghana needs to take advantage of utilizing the identified irrigation potential (Dickson, 1969).

The major task of all the successive governments have been how to adapt to food production to feed the growing population. Various interventions and strategies have been adapted to address crop failure and increase food production and security. The high levels of poverty in Northern Ghana have been attributed to the one rainy season experienced in the year (GoG, 2002) compared to the two seasons in the South. Farmers in Northern Ghana therefore cannot engage in all-year-round farming with one rainy season. Having realized the inability of rain-fed agriculture to guarantee food supply and all year round farming, construction of small scale irrigational dams is seen as supplementary means of increasing food production and income levels in Ghana. (Plan Ghana report; 2005). It is based on this fact that these dams were constructed to guarantee food supply all year round in the country in order to tackle the issue of food insecurity.

The Upper East Region has single rainfall maxima, which accounts for the uneven distribution and erratic nature of rainfall. The rainfall period is very short, between May and October with an accompanying prolonged drought period from November to April. The mean annual rainfall is about 100 to 115 centimetres. It is therefore evident that, when rain falls in May, yields are often low (Dickson & Benneh, 1988). The unfavourable climatic condition as well as the frequent failures in crop yields together with poverty resulted in the search for an alternative in food production to





reduce dependency on rainfed agriculture. Hence the convention has been to extend the growing season by means of irrigation in order to increase food crop production and to provide regular employment to rural people (Lowe, 1986).

Many regions including Upper East Region therefore adapted irrigation agriculture because it serves as a main source of rural employment, increase production comparatively to rainfed agriculture and reduces risks associated with climate uncertainty. On the basis of the above, Veia irrigation scheme started in 1970 and was only completed in 1980. The project was established to promote the production of food crops by small scale farmers within an organized and managed irrigation scheme, thus reducing food insecurity situation and increase the levels of income of the people in the catchment communities (Dickson & Benneh, 1988)

### **1.1 Statement of the problem**

Ghana is not self-sufficient in food production, and it has been difficult to ensure food availability in sufficient quantities all year round. Agricultural production in Ghana is primarily rainfed, so it depends on erratic and often insufficient rainfall. As a result, there are frequent failures of agricultural production (Dickson & Benneh, 1988).

Agriculture in the Upper East Region of Ghana is highly patronized which 72.10% of the population engages in for their livelihoods (GSS, 2012). However farming in the region is aggrcss with a single maxima and limited rainfall pattern which leads to



poor yields of crops. This goes a long way to worsen the poverty situation of the people in the region. In order to remedy the negative implications of this challenge, the Government of Ghana and other development partners provided irrigation facilities in some locations in the region to promote dry season farming so as to ensure all year rural farming activities so as to increase food production (Inkoom, 2011).

Formal irrigation which was introduced in the Region in the early 1950s is now not taken serious. This is because most of the irrigation facilities in the region are underutilized. Out of the 1,417 hectares of irrigable land available at the Veve irrigation scheme in the region, only 400 hectares representing 28% of the irrigable land has been utilised. Farmers are therefore left idle during the dry season (FAO, 2007). The problem persists even when about 70 % of the Upper East Region's populations are subsistence farmers who are also being described as the poorest and most vulnerable in terms of poverty analysis in Ghana (FAO, 2007). These farmers therefore experience or are at risk of experiencing food insecurity every year (World Food Programme, 2009).

These synopsis have therefore left people thinking as to the factors that account for the persistent food insecurity situations in communities where irrigation schemes are sited. This study therefore attempts to address the gap in the literature by *examining the relationship between participation in irrigation farming and food security status*



*among farming households in Veaa and its surrounding communities in the Bongo District of the Upper East Region of Ghana.*

## **1.2 Research questions**

The main research question of the study is; does household participation in irrigation farming influence household food security in Veaa and its surrounding communities?

The specific research questions therefore include;

1. What are the levels of food security statuses among users and nonusers of irrigation?
2. What are the contributions of irrigation to household food security status?
3. What are the determinants of household food security status?
4. What are the constraints to households achieving food security?

## **1.3 Research objectives**

The general objective of the study is to examine how household participation in irrigation farming influence household food security in Veaa and its surrounding communities. The specific are to;

1. Identify the food security indices among users and non-users of irrigation.
2. Determine the contribution of irrigation to household food security status.
3. Identify other determinants of household food security status.
4. Assess the constraints to household in achieving food security



#### **1.4 Justification of the study**

The motivation underlying this research is featured by the fact that Upper East Region of northern Ghana, of which Bongo District is not an exception, is considered the poorest region in the country. For more than a decade the level of poverty in the region continued to rise annually and now, four out of every five persons in that region are poor, though the region considered to have the largest irrigation facility in Ghana both in Tono and Veve communities. The various reasons assigned to explain this precarious phenomena lack clarity and therefore require investigation. (MoFA, 2007).

Besides that, the Upper East Region is also characterized by uni-modal rainfall of short duration and excessive evapotranspiration allowing only 4 to 5 months of farming and 7 to 8 months of extended dry season. Thus, irrigation is needed there to enable farming during the long dry season. Generally, however, rain-fed agriculture may not be able to support the future population of the nation unless coupled with investments in the irrigation sector. (MoFA, 2005). This investigation will generate baseline information that could be useful for the Ministry of Food and Agriculture, those who are managing change and the Ghana Irrigation Development Authority sub-sector in particular for planning and monitoring purposes. Attention could be redirected at the social aspects of managing the irrigation dam and similar projects so that income that is generated from these activities would be used to acquire food in the study area.



Equally, documentation from this research could serve as a useful source of information for future researchers and organisations involved in irrigation development and the provision of irrigation facilities in Ghana.

This development therefore buttresses the need to assess the link between irrigation farming and food security statuses among farming households or investigate the contribution of Veia irrigation project on household food security as food insecurity has severe negative ramifications on human development.

### **1.5 Organisation of the study**

This thesis is organized into five chapters. Chapter One which is the current chapter presents the Background of the study, Statement of the problem, Research questions and objectives and Justification of the study. Chapter Two covers review of relevant and related literature, both theoretical and empirical underpinnings of household's participation in irrigation farming and household food security. Chapter Three deals with research design incorporating the methodological framework and techniques employed in conducting the study. Chapter Four examines and discusses the results. The final Chapter (Chapter Five) contains the summary, conclusions and recommendations of the study.



## CHAPTER TWO

### LITERATURE REVIEW

#### 2.0 Introduction

This chapter presents a literature reviewed on irrigation and household food security status. It looks at concepts and development of irrigation, irrigation potentials and development in Ghana, concept of food security, trends and levels of food security, as well as measurement of food security and food security situation in Ghana,. The chapter ends with the synthesis of relevant and related empirical studies.

#### 2.1 The concept and development of irrigation

According to Mutsvangwa and Doranalli, (2006) irrigation is defined as the cultivation of land through the artificial application of water to ensure double cropping as well as steady supply of water in areas where rainfall is unreliable. Irrigation water is applied to ensure that soil moisture is sufficient to meet crop water needs and thus reduce water deficit as a limiting factor in plant growth (Van Averbeke *et al.*, 2011). FAO, (1997) defined irrigation as the supply of water to agricultural crops by artificial means, designed to permit farming in arid regions and to offset the effect of drought in semi-arid region. Hussain et al, (2002) also defined irrigation as the application of water to the land for the purpose of supplying moisture essential to plant growth. Irrigation is generally defined as the artificial application of water to the land or soil to assist in the growing of agricultural crops and vegetation of disturbed soils in dry areas and during periods of inadequate rainfall. It is an age-old art. Irrigation was practiced for thousands of years in the



Nile Valley. Egypt claims to have the world's oldest dam built about 5000 years ago to supply drinking water and for irrigation. At that time basin irrigation was introduced and still plays a significant role in Egyptian agriculture. According to Zewdie et al. (2007) irrigation has been practiced in Egypt, China, India and other parts of Asia for a long period of time. India and Far East have grown rice using irrigation nearly for 5000 years. The Nile valley in Egypt, the plain of Euphrates and Tigris in Iraq were under irrigation for 4000 years. Irrigation is the foundation of civilization in numerous regions. Egyptians have depended on Nile's flooding for irrigation continuously for a long period of time on a large scale. The land between Euphrates and Tigris, Mesopotamia, was the breadbasket for the Sumerian Empire. The civilization developed from centrally controlled irrigation system (Schilfgaard, 1994).

From the above, one can understand irrigation is an age-old art, perhaps as old as civilization. Nevertheless, the increasing need for crop production due to growing population in the world is necessitating a rapid expansion of modern irrigated agriculture throughout the world especially small- scale irrigation.

## **2.2 Irrigation Development in Ghana**

The development of formal irrigation is comparatively recent in Ghana. The first scheme was initiated in the early 1960s and 22 public irrigation schemes existed in the country by 2003 (GIDA & MoFA, 2008). The construction of most of the schemes was supply-driven and often emphasis was on developing exclusively

smallholder plots regardless of whether interested smallholder farmers and with irrigation experience were available and willing to cultivate them. In other instances, the sources where supply purchases should be made were fixed by the donor country without the choice of buying from the cheapest source. Informal urban and peri-urban irrigation was practised in and around the big cities of the country, where the urban population provides a ready market for their produce. Informal irrigation is not new in Ghana; for example in the Kumasi area it was found that it has been practised in at least part of the currently irrigated area for more than 30 years (Kyei-Baffour & Ofori 2006). The Ghana Irrigation Development Authority (GIDA) was set up in 1977 under the S. M. C. Decree 85. The Authority is wholly owned by the Government of Ghana and is finance by the government. By its act of incorporation, however, the Authority can borrow money from the open market for its development program.

The Ghana Irrigation Development Authority has been primarily responsible for identifying possible irrigation projects, and in some instances involved in the management and maintenance of irrigation schemes. Currently, there are twenty two (22) Irrigations Project all over the country constructed by the Ghana Irrigation Development Authority. In addition to this, there are 22 schemes constructed under the Small Scale Irrigation Development Project (SSIDP) and 6 schemes under the Small Farms Irrigation Project (SFIP). Each of these projects is less than 1,000 ha in size with the exception of the Tono and Kpong Irrigation Projects, which have about 2,500 ha and over developed. The main beneficiaries of the irrigation projects have



been indigenous small-scale farmers GIDA (2002). Below is a table showing the various irrigation schemes, year of construction, location or region and their status in Ghana.

**Table: 2.0 Important Features of the 22 Public Irrigation Schemes in Ghana**

No	Name of Scheme	construction year		Location/ Region	Status			
		started	Completed		Potential area (ha)	Developed area (ha)	Irrigated area(ha)	Irrigation Type
1	Veaa	1965	1980	U/E	1197	852	468	Gravity
2	Tono	1975	1985	U/E	3840	2490	245	Gravity
3	Kikam	1991	1993	Western	27.5	27.5	25	Gravity
4	Kpando-Tokor	1974	1976	Volta	356	40	10	Pump Sprinkler
5	Aveyime	1962	1975	Volta	150	63	59	Pump Gravity
6	Afife	1962	1983	Volta	950	880	880	Gravity
7	Weija	1979	1984	Greater Accra	2200	1500	210	Pump Sprinkler
8	Bontanga	1978/79	1983	Northern	570	570	570	Gravity
9	Golinga	1971	1974	Northern	100	40	20	Gravity
10	Libga	1970	1980	Northern	40	16	16	Gravity
11	Anum Valley	1990	1991	Ashanti	140	90	80	Gravity Pump



12	Subinja	1994	1976	Brong – Ahafo	121	60	18	Pump Gravity
13	Stata	1991	1993	Ashanti	56	34	34	Gravity
14	Tanoso	1975	1984	Brong- Ahafo	115	64	47	Pump Gravity
15	Mankessim	1974	1978	Central	260	17	17	Pump Sprinkler
16	Okyereko	1973	1976	Central	111	81	42	Gravity Pump
17	Afram Plains	1976	1980	Eastern	202	101	101	Pump Sprinkler
18	Akumadan	1976	1980	Ashanti	400	20	20	Pump Sprinkler
19	Ashaiman	1965	1968	Greater Accra	155	130	56	Gravity
20	Dawhenya	1975	1978	Greater Accra	450	200	150	Gravity Pump
21	Kpong	1959	1968	Greater Accra	3028	2786	616	Gravity
22	Dedeso	1975	1980	Eastern	400	20	0	Pump

Source: Author construct, 2014.



For the future, Ghana Irrigation Development Authority (GIDA) is reviewing the state of all the existing projects in order to recommend measures for improved participation and operation by the beneficiaries. In the past the medium and large irrigation projects have been managed by IDA under liberal conditions which may be termed “Civil Service Approach” (GIDA & JICA, 2004). This was not encouraging in generating enough revenue to support the operation and maintenance of the projects. The result is that most of these projects have run into a state of disrepair and require huge sums of money for their rehabilitation.

The future policy will be for IDA to help run medium and large irrigation projects along the lines of private enterprise. In those days big irrigation schemes were the order of the day. However, heavy investments in irrigation in some of the few big schemes that exist have failed to live up to expectations, as these schemes did not do well after some time due to problems of maintenance and improper management and operation, which resulted in the rapid deterioration of most of the schemes and a large sum of money is now needed to rehabilitate them (Kyei-Baffour & Ofori, 2006).

Emphasis has shifted away from big schemes towards small schemes that could be farmer-managed. However, an approach that recognizes that irrigation requires a new production culture is needed. A deliberate effort must be made to re-introduce irrigation to the Ghanaian farmer in a user-friendly manner. In each case, hands-on training in irrigation must be first delivered to farmers for a minimum of a year’s



production cycle or at least two harvests before they are allowed to continue on their own.

The Ghana Poverty Reduction Strategy 2003-2005 (GPRS) mentions irrigation development and rehabilitation of existing viable facilities to attract private sector management as part of its package of infrastructure enhancement. The GPRS approach to the irrigation sub-sector development can be viewed in two categories, i.e. with regard to micro- and small-scale irrigation and with regard to medium- and large-scale schemes.

With regard to micro- and small-scale irrigation, the GPRS was focus on:

- Development of valley bottoms in order to utilize waterlogged river valleys for cultivation of food and other crops by using wet season soil water;
- Provision of small dugouts, boreholes, tube-wells and other simple structures especially in the three northern regions and the Afram Plains;
- Rehabilitation of all viable irrigation facilities;
- Use of a minimum of machinery and more labour to generate employment in construction works;
- Introduction of some non-traditional exports such as mangoes, pawpaws, cashew nuts, and ginger (GIDA and MoFA 2008).

Regarding medium- and large-scale irrigation, the GPRS foresees the construction of major dams, pumping stations, diversion structures, canals and long distance



conveyance pressure pipe systems. These facilities are to be provided purposely for commercial operators and investors.

Agricultural water use is expected to increase significantly in the future once the funding required for new scheme developments has been mobilized. But because of the high cost of investment in irrigation schemes, the cost of water delivered to farmers would be high (Hussain et al. 2003).

The water demand for the year 2020 was estimated by population projection and projected areas to be irrigated by then, also assuming the following:

- Covering 100 percent of the rural population with potable water by 2020.
- Rehabilitating existing small- and medium-scale irrigation projects with a total area of 3 500 ha.
- Rehabilitating 44 and 20 dams in the Upper East and Upper West regions respectively.
- Developing 20 stock watering points in the Upper West and Northern regions to support the livestock development projects.
- Surveying, designing and developing 1 000 ha of small-scale irrigation projects in the northern and southern parts of the country where rainfall is deficient, provision of potable water and irrigation water supply for selected agricultural sector investment projects.
- Developing 3000 ha of large-scale irrigation downstream of Kpong hydropower project.



Based on these assumptions, the projected future annual water demand by 2020 is 617 million m<sup>3</sup> for irrigation, 32 million m<sup>3</sup> for livestock and 463 million m<sup>3</sup> for rural and urban water supply (municipal and industrial). This represents about a 130 percent increase in present water use. Groundwater abstraction is projected to increase by 69 percent in order to meet the water demand in 2020.

### **2.3 The Veia Program**

The Upper East Region of Ghana and the other two Northern regions of Ghana where there is irregular rainfall patterns, small dams have been constructed on small rivers and streams to ensure a year round growing season and also water supply for livestock and domestic purposes as well. Small dam development in the Northern regions of Ghana have been considered as one of the solutions for curtailing the higher incidence of poverty by improving the standard of living of the people through improved smallholder irrigation techniques and livestock production (GoG, 2002). They are seen as important tool in achieving some of the goals of vision 2020 of Ghana and also the United Nations Millennium Development goals of poverty reduction (GoG, 2002). The Veia Irrigation Project is one of the two irrigation projects under the management of Irrigation Company of Upper East Region (ICOUR). The scheme is located in the Upper East region of Ghana and lies between latitude 10° 45' N and longitude 1° W. The project is situated at Veia which is near to Bolgatanga. The construction of the Veia project was started in 1965 and completed in 1980. It lies in the Guinea Savannah ecological zone of Ghana. It has a potential area of about 1197ha and the area developed is about 850ha with an irrigable area of



about 468ha. The major objective of this scheme is to promote food security status of the people of the region.

## **2.4 Irrigation potential in Ghana**

Irrigation development in Ghana has followed the global irrigation investment pattern, with a peak in 1970. However, the scale of overall development has remained low. Of the total 6.9 million ha of cultivable area in 2007, there were only 33,800 ha of irrigated land. This represents less than 0.5 percent of the total area. Of the gross estimated 1.9 million ha of potentially irrigable area, less than 2 percent has been developed (Kunateh, 2010). Currently, public irrigation systems play an insignificant role in the overall agricultural economy of Ghana despite substantial efforts to develop the sector since the 1950s. The cost of development (and also of rehabilitation) per unit area in use or per unit volume of water supplied is higher than the figures for comparable developing countries (Inocencio *et al.*, 2007). Capacity underutilization is a major problem in many existing irrigation facilities. The potential areas that can be developed in each of the public irrigation schemes are much higher than the developed or equipped areas. In addition, in any given year, only a fraction of the developed or equipped area is actually cultivated. Rehabilitation of many of the irrigation schemes are long overdue.

Unfortunately, the quality of the implemented rehabilitation projects is also questionable, as some schemes still suffer from structural defects despite repeated rehabilitation works. Despite considerable potential for development and the



emphasis placed on irrigation development in many plans, less than two percent of the total cultivatable area in Ghana is irrigated (GIDA&MoFA 2008). Moreover, within this cultivable area mentioned earlier, researchers find it difficult to locate where the different types of irrigation infrastructure are used and to what effect. Less than a third of the estimated total irrigated land in Ghana lies within 22 well-known public schemes, not enough is known of the location, development and management of the informal irrigation schemes that account for the remaining two-thirds of total irrigated land. Although donors and policymakers express interest in providing new funds for irrigation development, the lack of reliable data on where some irrigation schemes currently exists, trends in their development, and opportunities and constraints within formal and informal schemes undermine consensus about how to build on what already exists in the sector (GIDA & MoFA, 2008).

### **2.5 The concept of food security**

The term food security originated in the mid-1970 and attracted much global attention during the world food conference in 1974. Since then there has been considerable debate on the subject and several revisions to operational definition on the term. The definition of food security coined in the 1970s was primarily concerned with food supplies as according to the United Nations' Food and Agricultural Organization (FAO), "it was the availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" ( FAO, 1970). The food crises of 1973-75, which came about through a series of bad weather conditions





around the world and rapid increase in the price of petroleum, gave rise to the problems of food insecurity, famine and hunger. These situations led to deep public and institutional interest in ensuring the stable availability of adequate food supplies, together with relatively steady prices at the national and global levels.

In 1983, the FAO revised this definition to incorporate the demand side of the issue, highlighting access to food at household and individual levels in addition to national and global levels. Ensuring that all people at all times have both physical and economic access to the basic food that they need. The realization that, the availability alone could not ensure the adequate consumption of food had dawned. There was an increasing interest between poverty reduction and food security. A number of factors contributed to the dialogue in this period, including the era of structural adjustment in the 1980s, where poverty reduction and basic needs often took a backseat to debt management and macroeconomic stability, and the fact that the Green revolution had not led to rapid improvement in poverty and malnutrition levels everywhere. In 1986, the World Bank also highlighted the temporal dynamics of food security by introducing the distinction between chronic and transitory food insecurity (World Bank, 1986). The former is associated with the factors such as low incomes and structural poverty, while the latter is often caused by events such as economic crises, conflicts or natural disasters.

The 1990s saw further deliberations on the concept of food security and its widespread acceptance of the issue as socio-political construct, as well as a moral





and humanitarian matter. The importance of essential micronutrients, food composition, safe water, hygiene, sanitation, intra-household allocations and effective livelihood strategies to reduce vulnerabilities and manage risk, was highlighted. Food security becomes a context specific concept that had to include people's food preferences. It also changed from an end in itself to a group of intermediating actions that could help promote a healthy and active way of life (FAO, 1996). The world food summit in 1996 defined food security, at the individual, household, national, regional and global levels which is achieved "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO,1996). The definition of food security was refined in 2001 to include the stability context. Food security was defined as the situation that exist when people at all times have physical social and economic access to sufficient, safe and nutritious food for active living and their food preferences. However, for the purpose of this research, the term food security will be based on the 2001 definition which comprises four dimensions, availability, access, utilization and stability. The four dimensions of food security that determine the level at which a community is placed in relation to vulnerability to hunger are;

- i.* Food availability
- ii.* Food accessibility
- iii.* Stability
- iv.* Utilization/nutrition

### 2.5.0 Food availability

Availability refers to the physical existence of food. On national level food availability is a combination of domestic food production, commercial food imports and exports, food aid and domestic food stocks. On household level food could be from own production or bought from the local markets. Regarding food production, water resources are required to produce the crops. Due to population growth and climate change, the pressure on existing natural resources, namely land and water, increases. Impacts of climate change are often leading to land degradation, lack of irrigation water, reduced soil moisture and therefore losses of economic livelihoods. Together with an increase in conflicts over usage of water resources (cultivation of crops for energetic use vs. cultivation of crops for nutritional use, use by other sectors like drinking water, industry and environment), this may be a threat for long-term food security. The Stockholm International Water Institute (SIWI) emphasizes the growing importance of green water, i. e. the water hidden in the ground as soil moisture (while blue water refers to water available in lakes, rivers and aquifers) (SIWI, IFPRI, IUCN, IWMI. 2005). With suitable adaptation measures to soil such as irrigation systems improving water-use efficiency through cultivation methods and technologies, or infrastructure development for water harvesting and (re)use of marginal quality water and treated waste water, or improved soil-water management in rain fed systems like, the resilience of agricultural systems can be strengthened, risks reduced and livelihoods secured. Support of local water user groups and strengthening their planning and management skills can help minimize risks of scarce resources and reduce conflicts (Klennert, 2009)





### **2.5.1 Food accessibility**

Access is ensured when all households have enough resources to obtain food in sufficient quantity, quality and diversity for a nutritious diet. This depends mainly on the amount of household resources and on prices. In addition, accessibility is also a question of the physical, social and policy environment. Drastic changes in these dimensions may seriously disrupt production strategies and threaten food access of affected households. As an example, developing countries may be affected by severe droughts or floods more and more frequently. Thereby, the harvest volume shrinks and the prices for food increase, affecting on the availability and accessibility of food for households. To prevent such negative developments, different technical adaptation measures exist. The construction of infrastructure such as small dams and reservoirs or water spreading weirs to hold back water and raise the shallow groundwater tables is one of them, dykes and improved drainage systems for floods are other ones. In addition, the preservation and rehabilitation of ecosystems, flood sensitive planning or early warning systems and emergency plans further enhance the capabilities to deal with extreme weather events and to preserve the physical environment (USAID, 1995).

### **2.5.2 Utilization/Nutrition**

Use describes the socio-economic aspects of household food and nutrition security, determined by knowledge and habits. Assuming that nutritious food is available and accessible, the household has to decide what food to purchase and how to prepare it as well as how to consume and allocate it within the household.

Another aspect is the biological utilization. This relates to the ability of the human body to take food and convert it. This gained energy is very important when it comes to daily physical activities, for example working in agriculture. Beside that utilization requires a healthy physical environment and adequate sanitary facilities as well as the understanding and awareness of proper health care, food preparation, and storage processes. In this context safe drinking water plays an important role, especially for preparing food and creating a healthy environment for the population. Safe drinking water is connected to groundwater which is often contaminated through human, industrial or agricultural waste water in combination with other factors 884 million people worldwide have no access to adequate drinking water (IICA,2009).

### **2.5.3 Stability**

Stability describes the temporal dimension of food and nutrition security, respectively the time frame over which food and nutrition security is being considered. Stability is given when the supply on household level remains constant during the year and in the long-term. That includes food, income and economic resources. Furthermore it is important to minimize external risks such as natural disaster and climate change, price volatility, conflicts or epidemics through activities and implementations improving the resilience of households. Such measure include insurances e.g. against drought and crop failure as well as the protection of the environment and the sustainable use of natural resources like land, soil and water (Klennert, 2009)



## 2.6 Different levels of food security

Basically, food security can be divided into global, national, household, and individual levels. Although some see global food security as a combination of separate food secures nations. And some see the household level as the basic bottom level of food security. All the different levels are connected however and the crucial things are: how well food is distributed on a certain level from one place and time to another place and time (e.g. in the form of food aid from surpluses); and how well food is distributed from an upper level to a lower level (e.g. how well food aid received by a state reaches the people). The distribution and connection between different levels often needs roads, railways etc. which do not generally exist on the household and individual levels of the poorest countries (Chen and Kates, 1994).

### 2.6.0 Global level

Providing food security to all the people on earth – which means that the global production should be sufficient to feed all the people. Does the world have such a capacity? Which countries would export and which countries would import food? What kind of global solidarity would it require? If the world is examined as one, and the people as being on a same boat - as we are indeed - this would certainly require a collective acknowledgement of food as a human right and concrete actions, like a safety net to provide food for people in hunger who cannot afford to buy it. The other aspect to global food security is to achieve it through separate food securities of each nation. This means that all the nations should get along by themselves, i.e. if a nation could not be self-sufficient, it could export something else than food and with that



income it could import food it needs. It is not that simple nevertheless in the nations where the problems of resource scarcity and poverty tend to accumulate. Globalization seems to unite the world, but the “world as one”-viewpoint seems not to be realistic at all. The global food security seems to need viewpoints, the ‘world as one’ and the world with the emphasis on the national self-sufficiency (Alexandratos, 1995).

### **2.6.1 National level**

A national level is often understood as a nation’s capability to be self-sufficient. The self-sufficiency is, though, very hard to achieve in developing countries with high population, high population growth, water and land scarcity, etc. Self-sufficiency is not although the only way to achieve national food security. Through global or regional markets, by importing food, a state can buy supplementary food and be self-reliant. To buy food requires however capability to get income and thus have the power demands. The developing countries with insufficient water and land resources to achieve self-sufficiency are often poor and not able to pay for food they would need to import. One additional aspect to food importing is also the loss of self-determination with respect to food security: the importing country is on the mercy of the markets and the production of food producing countries. This would be a threat in a global scenario in which the world doesn’t have the kind of solidarity and help providing as in the “world as one”- scenario (Chen and Kates, 1994).



The income viewpoint is also connected to agriculture, since these countries are often very dependent – directly or indirectly – on agriculture for their income. Thus the agricultural constraints are also constraints for the economical and overall development (Like building up small industry), through which the poor agriculture-dependent countries could stand up economically and maybe afford to import food (Chen and Kates, 1994). This agriculture centered development circle, can also be seen inside a nation or a region: food production can create jobs outside the agriculture as well: farmers have money to demand, which can create supply from other small-scale sectors. Thus, the importance is on the distribution of agriculture originated income: how many villagers can benefit from agriculture. So agriculture is very important from a national and regional livelihood point of view, especially as the amount of people dependent on agriculture continues to grow (Alexandratos 1995).

### **2.6.2 Household level**

Food security at a household's means the capability of the household (family) to meet food requirements of all the household members (Chen and Kates, 1994). Alexandratos (1995) recognize the fundamental importance of the households: The important thing is for policies to recognize that the first priority of many farmers is household food security and family welfare. The family is the basic functioning unit. And if the family cannot produce its own food, it should have entitlements to food, or the economic access to it. Here the deficiency is often, the assumption that all the





households with same income and expenditure levels have equitable entitlements to food (Chen and Kates, 1994).

### **2.6.3 Individual level**

Have all the members of the family equal access to food? How is food distributed in a family? And all the individuals do not belong to a household or a family. How are they entitled to food, if they are e.g. unemployed? On the individual level food security comes back to its definition and the measurement of enough food in quantity and quality for all the people, and thus for every individual. Food security is not just a supply issue but also a function of income and purchasing power, hence its relationship to poverty (Alexandratos, 1995).

### **2.7 Measurements of food security**

There is no single indicator for measuring food security in households. However, measuring the required food for an active and healthy life and the degree of food security attained is a question to be addressed in a food security study. For the purpose of this study, the calorie intake of the individual or household will be calculated using the food security index formula which is calculated by dividing the calorie available in the household over the calorie required by the individual or the household. In measuring food security, different indicators are needed to acquire the various dimensions at the country, household and individual levels (Hoddinot, 1999). At the national or regional level, food security can be measured in terms of food demand (requirements) and supply indicators. The supply of food may be from



current production and stocks and from previous production whereas the need has to be determined on the basis of biological or nutritional requirement of a given society for a certain period of time usually a year or a day (Hoddinnott, 1999).

The most commonly used indicators which used to measure household food securities are availability, food accessibility and utilization indicators. These indicators embrace meteorological data, information on natural resources, agricultural production data, marketing information, food balance sheet, sales of productive assets, diversification of income sources and household budget expenditure security (Jacobs, 2009). Thus, it is possible to say that there are no single and one best food security measure that is universally accepted. It is up to the researcher to select an indicator or a combination of indicators that suits the objective of the study, the level of aggregation and specific circumstances of the study and the study area. Therefore, in this study the minimum calorie requirement would be used as a benchmark to differentiate food secure and insecure household among the total sampled households and to identify their determinants (Frankenberger, 1991).

## **2.8 Irrigation and food security**

Irrigation development is an important part of policy development for sustainable economic growth of any country especially third world countries. The initiative for development of irrigation mostly has been taken up by governments and to some extent development agencies since farmers are unwilling or unable to undertake



irrigation development due to the large amounts of money required for the initial development (Alibaruho *et al*, 1979).

Irrigation contributes immensely to agricultural production in the world. About 40 per cent of the total world food crops produced is through irrigation undertaken on only 17 percent of the total agricultural land in the world (Upton, 1996; IPTRID, 1999). This means that 60 per cent of food crops are produced with rain-fed agriculture. The marginal productivity of irrigated agriculture is therefore higher than that of rain fed agriculture. Shah (2008) has therefore concluded that irrigation is the lifeline for sustained agriculture. Irrigation increases agricultural production in a year by providing all year round farming opportunities through the artificial supply of water to crops. It has the ability to regulate water supply to crops especially at times when the crops need water most and provides drainage facilities for the disposal of excess water, which is impossible with rain-fed agriculture (Rydzewski, 1987). Together with other agricultural inputs like fertilizer, improved seed varieties, and technologically improved cropping systems; the yield per acre of irrigated land far outweighs that obtained through rain-fed agriculture on the same size of land (Shah, 2008).

Hussain *et al* (2003) identified five key interrelated dimensions of the irrigation/poverty alleviation relationship. This includes production, income/consumption, employment, vulnerability/food security, and overall welfare. All year round farming and technical efficiency towards increased agricultural





production made possible by irrigation reduces poverty drastically especially in agrarian economies (Kimenyi, 2002). Poverty reduction in India from 50 per cent to 35 per cent between the years 1970 and 1990 has been attributed to the development of irrigation schemes (Shah, 2008). Irrigation reduces poverty by offering employment especially to rural households, ensuring food security and by stabilizing (or lowering) food prices both in the rural and urban markets (Lipton et. al 2003). Irrigation also increases the supply of agricultural input to industry thereby fostering agro-industrial growth (Hussain et.al 2003; Shah, 2008). The supply of cheap raw materials to industry will also ensure price stability or low prices of industrial output of goods. Irrigation therefore alleviates suffering, preserves life, averts famine and advances the material prosperity of a country (Shah, 2008). With the advent of the Green Revolution in the mid-1960s, irrigated agriculture in Asia experienced significant expansion. Irrigation has been regarded as a powerful factor in increasing crop productivity, enhancing food security, expanding opportunities for higher and more stable incomes and employment and for increasing prospects for multiple cropping and crop diversification. Massive investments have been made in the development of irrigation infrastructure in Asia, with irrigated areas expanding from 90.17 million hectares (M ha) in 1961 to 190.39 M ha in 2001. As a result, there have been dramatic increases in aggregate agricultural production. For example, cereal production in developing Asia increased from 309 million tons in 1961 to 962 million tons in 2001. The expanded production has greatly improved incomes and welfare of producers, and benefited the overall population by providing more food at reduced prices.

Today, the world has more than enough food to feed everyone, yet 850 million are food insecure. Achieving food security requires adequate food availability, access, and use. Agriculture plays a key role in providing (1) food availability globally (and nationally and locally in some agriculture-based countries); (2) an important source of income to purchase food; and (3) foods with high nutritional status (FAO, 2006). Irrigation therefore play a vital role in agriculture production which have a trickle-down effect on food security situation in the world.

## **2.9 Food Security situation in Ghana**

About 1.2 million people, representing 5 percent of Ghana's population, are food insecure. Thirty four percent (34%) of the population are in Upper West region, followed by Upper East with 15% and Northern region with 10%, amounting to approximately 453,000 people (FAO, 2011). Throughout the country, about 2 million people are vulnerable to become food insecure. Their food consumption patterns were barely acceptable at the time of the survey and can quickly deteriorate following a natural or man-made shock (FAO, 2011). About 507,000 (40%) people are vulnerable of becoming food insecure in the rural areas of Upper West, Upper East and Northern regions. Up to 1.5 million people vulnerable to food insecurity live in the rural and urban areas of the remaining seven regions, with the largest share of them in Brong-Ahafo (11%), in Ashanti (10%), followed by Eastern (8%) and the Volta region (7%) (FAO, 2011).



### 2.9.0 Food Security Groups by Region

The World Food Programme (2012) has observed that with the exception of maize, other major cereals (millet, sorghum and rice) consumed largely by majority of the households in the Upper East region are all trading at higher prices as compared to 2011 price. The year-to-date increase in the price of maize is 5%, but when compared to the start of the major harvest in November, the price of maize went up by 7%. From the nominal wholesale price of GHC 150 per 100kg bag, the price of millet decreased by (-12%) in November 2012 when the major harvest occurred. Although these price trends tend to indicate a certain degree of market stability, the increases over the previous year and the five-year average is significant and could have the effect of reducing food access for a large number of food deficit households in the region (WFP, 2012). See table 2.1

**Table 2. 1: Food Security Groups by Region**

<b>Food Security Groups by Region</b>	<b>Severely food insecure (%)</b>	<b>Moderately food insecure (%)</b>	<b>Mildly food insecure (%)</b>	<b>Food secure (%)</b>
Northern	2.3	7.4	10.6	79.7
Upper East	6.4	21.9	10.1	61.7
Upper West	1.4	14.8	7.5	76.3

**Source: WFP, 2012**

### 2.10 Irrigation and household food security: some empirical evidences

Van Averbek (2012) investigated the factors that contribute to differences in the performances of smallholder irrigation schemes in Vhembe district in South Africa. Although arguing that smallholder performance has been below expectations, gross



margin analysis by Yokwe (2009) and Hope *et al.* (2008) indicated that irrigators have somewhat greater gross margins per ha compared to non-irrigators. For the Zanyokwe and Thabina irrigation schemes, Yokwe (2009) found greater gross margin per ha among irrigators for all the crops that were included. Hope *et al.* (2008), however, found that irrigation schemes provide expected incomes and food for those plot holders with irrigation access. The study conducted by Tekana and Oladele (2011) using the OLS procedure, concluded that irrigation plays a central role in the improvement of household income, rural livelihood and food security.

Gebregziabher *et al.* (2009) and Kuwornu and Owusu (2012) evaluated the impact of access to small-scale irrigation on farm household welfare using the propensity score method (PSM). According to Gebregziabher *et al.* (2009), the average income of non-irrigating households was less than that of the irrigating households by about 50% in Ethiopia. The study also found that farm income is more important to irrigating households than to non-irrigating households, and off-farm income was negatively related with access to irrigation.

Kuwornu and Owusu (2012) concluded that irrigation investment in Ghana is justified due to significant irrigation contribution to consumption expenditure per capita in farm households. Dillon (2011) investigated the impact of small-scale irrigation investments on household consumption, assets and informal insurance in Mali using both PSM and the matched difference-in-difference method. Both



estimation methods confirmed the positive role played by irrigation schemes on household consumption and asset accumulation.

Tesfaye *et al.* (2008) and Bacha *et al.* (2011) both assessed the impact of irrigation farming on household welfare in Ethiopia using the Heckman's two-step estimation procedure. Both studies observed significant welfare differences between irrigators and non-irrigators, and concluded that access to irrigation had played a part in those observed differences.

### **2.11 Empirical Evidences on determinants of food security in General**

A study on livestock was conducted by Ndlovu (1989), who focused on the role of ruminants in promoting food security in farming systems in the SADC region. Ndlovu (1989) found that livestock are important to food security in the SADC region as sources of manure, draught power, cash income, food (milk and meat) and as long-term investments. Zindi and Stack (1991) did a survey on the contribution of livestock to household's food security in communal areas. The most important livestock types in communal areas are cattle, chickens and goats, each of which serves different functions under different household circumstances. Cattle are generally regarded as an investment and a production input while smallstock, especially goats, are viewed as a ready source of cash (Ndlovu, 1989). Thus, FAO (1997) proposed a food based strategy to alleviate rural food insecurity that included smallstock (goats and sheep) and vegetable gardens as well as formal agriculture, especially the rearing of poultry to improve household food security. FAO (1997)





showed that smallstock are easy to keep as they can survive in harsh conditions and are able to feed on low quality crops as compared to cattle.

A study in Nigeria using Tobit model found that sex of head, educational level, dependency ratio, network, farm size, input usage, commercialization extent, being a member of cooperative, food expenditure, remittance have negative influence on food insecurity, whereas age of head, household size, positively influences the problem and all the variables are significant (IKPI et al, 2004).

A Study by Alarcon et al (1993) for smallholder farming households in west highland of Guatemala found that lack of access to credit and cash crop production displace food crops and household consumption of own production is reduced. Thus the household's vulnerability to food insecurity tends to increase. However another study in Malawi by Diagne (1998) found that formal credit has marginally beneficial effects on household annual income. However, these effects are very small and do not cause any significant difference between the per capita incomes, food security, and nutritional status of credit program members and non-current members.

Ramakrishna and Assefa (2002) undertake an empirical study in the Amhara regional state of Ethiopia, in the case of North Wollo. The data analysis based on food balance sheet and aggregate food security index reveal that the North Wollo zone is highly food insecure area and the majority of the sampled household depends on famine relief assistance. In addition they tried to find the cause of food insecurity



using logit model and found that cereal production, education, fertilizer consumption, livestock, land size, reduce the probability that household food insecure, while family size increase the probability of insecurity (Ramakrishna and Assefa, 2002).

In a study conducted in Kwazulu-Natal to assess the impact of land reform programme in South Africa, it was realized that it failed to integrate food security concerns and the needs of rural women. The study suggested that there are important differences within and between households headed by women and communities with respect to security levels and strategies to attain food security. It was noted that there is great concern in Southern Africa on issues of poor governance, economic mismanagement and scant regard for adequate food and satisfactory quality life as basic human needs have contributed significantly to the acute and chronic insecurity in most parts of the region (Boyd and Turner, 2000).

The most common asset in rural areas is landholding and this is a good indicator of poverty when income is unobserved (Ravallion, 1989). Households with small farms are prone to food insecurity. In addition, land quality has been found to provide a good amount of yield in communal farms. In most communal areas, farms are of relatively poor quality and require the use of chemical fertilizer (Rutsch, 2003).

The Consortium for Southern Africa Food Security Emergency and the World Food Program have jointly implemented a food and livelihood security monitoring system



in six countries in the Southern Africa region since 2002. Based on three round surveys the monitoring system that covered more than 12,000 households, the organizations conclude that food aid can have a positive impact on beneficiary households in several ways. The first is to provide a short-term safety net and a source of calories to individuals so that they can remain productive enough to endure the food security crisis. Food aid can also help households differ spending, avoid selling negative assets, and avoid invoking other negative coping behaviors. Evidence from the CHS clearly shows that food aid has contributed to declining use of coping strategies to meet food needs in beneficiary populations (WFP, 2009).

A study conducted in Uganda on the main cause of seasonal food insecurity revealed a data associated with weather related problems (little or too much rain) followed by pests and disease. Factors that contribute to such insecurity were inadequate labor, inadequate land, not growing enough food during the seasons and soil infertility, poor health, lack of planting materials, lack of oxen for ploughing and so on. The farmers coping strategies include donations from relatives and neighbors, reducing the number of meals or ration, sale of livestock and exchange of labor for food. The study also shows that female-headed households were more food insecure than male-headed households. Furthermore, no specific pattern that indicates the higher level of education of the household head, the more food source a household will be (Bahigwa, 1999).



Off-farm employment opportunities in rural Ethiopia are limited in both availability and income-generating potential. Only 44% of rural households surveyed by the Ministry of Labor in 1996 reported any non-agricultural sources of income, and these contributed only for 10% to household income (Befekadu and Berhanu, 2000). Another survey in Hararghe Region confirmed that off-farm activities generated only petty incomes: women collect and sell firewood and forage, men and women seek irregular, low-paid work as farm laborers, and some men migrate seasonally (ICRA, 1996). In a survey conducted in the Amhara region, 25% of households had one or more members migrate during the dry season in search of work, mostly to nearby rural areas. One in three migrants had difficulty securing employment, while half brought back no food or income for their families (FSCO, 1999).

Off-farm labour is an important source of income for most smallholder farmers. Off-farm income is positively associated with higher and less variable total income (Jayne *et al*, 1994). Some studies have also shown that off-farm income has a positive effect on the adoption of expensive traction technology and good quality inputs, which results in high productivity levels (Zindi and Stack, 1991). Thus, it is clear that income diversification can have a positive effect on food access by increasing total incomes and under proper circumstances increasing investment in agriculture (Jayne *et al*, 1994).



## 2.12 Conclusion

In conclusion, achieving improved food security at the global, national, household and individual level can be met through efficient food production and distribution system throughout the world. In order to overcome the food insecurity situation of countries, governments' policies have to be centred on tackling food insecurity crises at grass root level through increased production as much as possible. To achieve household food security, irrigation agriculture should be given the needed attention as it's the better option to solve the issue of rainfall variability. Therefore emphasis on agricultural production using irrigation is, however, one aspect of approaching food insecurity at household level.



## CHAPTER THREE

### METHODOLOGY

#### 3.0 Introduction

This chapter presents the methodology of the study. It considers the study design, description of the study area, sampling technique, data collection approach, data analysis and presentation, conceptual framework, theoretical framework and estimation method. Regression diagnostics and post estimation tests are also carried out.

#### 3.1 Research design

The methodological approach adopted in this study is deeply rooted in the positivist philosophy which believe that objective knowledge is possible and can be quantified. It is on this bases the study sort to quantify food security status of farming households by ascribing numbers to households to represent their food security statuses. Positivism subscribes to the application of natural science methods and practice to study of human behavior in social sciences. (Denscombe, 2002; Grix, 2004). The epistemological assumption that follows from positivism is that, human behavior can be captured in numerates and hard data seeking to measure and describe social phenomenon by attribution of numbers (Miller and Brewer, 2004) and this is perfectly in line with the objectives of the study. This study therefore adopts a quantitative cross-sectional study aimed at finding association between households' participation in irrigation farming and households' food security status. This research design is therefore informed by the nature and structure of the study in



terms of data type and data collection technique and the study design is chosen based on the objective and the fact that it provides consistent and easy verifiable results.

### **3.2 The Study Area**

Veve in the Bongo District lies within the Guinea Savannah woodlands ecological zone in Ghana. The Bongo District is one of the nine districts in the Upper East Region of the Republic of Ghana. The District is generally low-lying with an undulating topography. The drainage system of the District is constituted mainly around the tributaries of the Yarigatanga River. There are some dugouts and ponds in the district which are used to water livestock and irrigate crop farms in the dry seasons. The climatic conditions are influenced by two air masses namely, the north east trade winds (harmattan) and the south western trade winds (monsoon). The harmattan wind is felt between the months of November and April. Temperature during this period ranges between 42°C in the day and 18°C in the night. The district experiences the south western trade winds air mass between May and October. This brings the precipitation averaging 950 mm per annum to the area good enough for the production of both cereals and root crops.

Two main types of soil are present within the district namely the savannah ochrosols and groundwater laterite. The northern and eastern parts of the district are covered by the Savannah ochrosols, while the rest of the District has groundwater laterite. The Savannah ochrosols are porous, well drained, loamy, and mildly acidic and interspersed with patches of black or dark-grey clay soils. This soil type is suitable



for cultivation of cereals, legumes and vegetables which accounts for the arable land sites including most parts of the Veia Irrigation Project sites where both wet and dry season farming activities are concentrated.

To adapt to the problems caused by the vagaries of the climatic conditions, The Veia Irrigation Scheme in the Bongo District in the Upper East Region is an intervention measures to promote an all-year round agricultural production. Food security is as low as 1.3% with 15% of the population having limited access to sufficient and nutritious food as compared to a national average of 5% (WFP, 2009).

### **3.2.0 Profile of Veia Projects**

The Veia irrigation project is one of the strategic investment in the Upper East Region of Ghana. These project is multi-purpose such that it involves crop production, fish production, tree production, livestock production as well as domestic water supply. The Veia project got started in 1960 and 1975 but became fully operational in 1980 and 1985 respectively (Gordon, 2006). Some facts about the irrigation projects are shown in Table 3.0.





**Table 3.0 Facts and Figures of the Veia irrigation project**

<b>Veia Irrigation Project</b>	<b>Area</b>
Catchment Area	136 Km <sup>2</sup>
Reservoir Area	40.5 Km <sup>2</sup>
Volume (10 <sup>6</sup> m <sup>3</sup> )	17
Gross Project Area	1,197 hectares

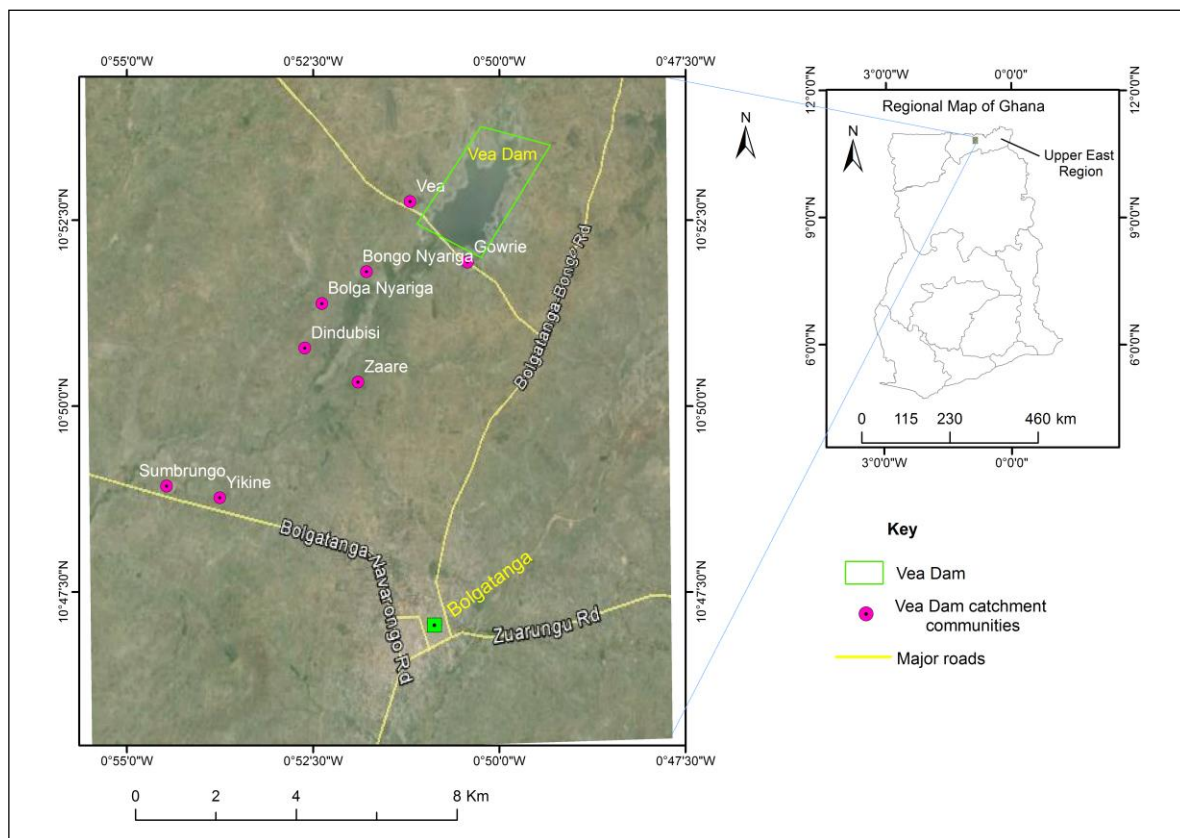
Source: ICOUR (1995)

### **3.2.1 Catchment Communities**

The catchment communities of Veia irrigation dam are Veia, Gowrie, Bongo Nyariga, Bolga Nyariga, Dindubisi, Zaare, Yikine and Sumbrungu. However, people from outside these catchment communities have access to the irrigation facilities as well as harvesting of fish (ICOUR, 1995). Appropriate examples are Balunge and Bongo Kukua in the case of Veia project. See Figure 3.0



**Figure 3.0 Aerial view of Veia irrigation Dam and its catchment communities**



Source: Adapted from Google Earth, 2013

A significant feature of the veia irrigation scheme is that the project have been developed on both sides of the river valley. The cropping areas are divided 50:50 between upland and lowland areas. Uplands are the sloping areas of light coarse textured free draining soils and the plots are designed for furrow irrigation. Crops grown in upland plots include tomatoes, onions, millet, pepper, groundnuts, sorghum and maize. Lowlands are the more level areas of heavier textured soils adjacent to the old river course. These lowlands are used for rice production and the irrigation method is by flooding. During the dry season, farmers depend on irrigation to



cultivate paddy rice, onions, tomatoes, soybean, and pepper. In the wet season the farmers depend on rains water and supplementary irrigation for their rice, groundnuts, millet/sorghum, cowpea and maize.

### **3.3 Population and sample size**

This study population includes farming households in the catchment area of Vea irrigation dam in the Bongo district of the Upper East region of Ghana. The catchment communities of Vea irrigation dam are Vea, Gowrie, Bongo Nyariga, Bolga Nyariga, Dindubisi, Zaare, Yikine and Sumbrungu. However, people from outside these catchment communities have access to the irrigation facilities as well as harvesting of fish (ICOUR, 1995). Appropriate examples are Balunge and Bongo Kukua. Due to time and financial resources constraints, the sample size for the study includes 160 farming households who are mostly primary decision making unit of household and major providers of basic needs of the households including food and shelter. This sample size is also justified statistically since it is large enough to make generalisations about the population.

### **3.4 Sampling technique**

Multistage sampling technique was employed in selecting the respondents for the study. This involved using a mixture of probability and non-probability sampling procedures at different stages in order to select the final sample. The first stage of the sampling procedure was the use of purposive sampling technique to select four communities namely Vea, Bongo Nyariga, Gowrie and Zaare. In the first place, these



four communities were selected purposively because they have been observed by the District office of MoFA to be the leading producers of the food crops considered by this study. The other communities are noted for the production of mainly vegetables. Secondly, they are more proximal to the dam than the other communities in the District.

The purposive technique was used because, according to Morse and Richards (2002), in an inquiry of this nature, researchers deliberately select participants so that the phenomenon under study is described and revealed by participants who have special attribute within the area of investigation and are willing to participate. Also, the choice of this technique was further supported by Palys's (2008) argument that the primary consideration in purposive sampling is the judgment of the researcher as to who can provide the best information to achieve the objectives of the study and if the interest of the researcher is to construct a historical reality, describe a phenomenon or develop something about which only little is known. In this case, the judgment of the investigator was more important than obtaining a sample.

The second stage was the selection of respondents from the purposively selected communities. A non-proportional sample selection in each community was adopted. This implies that, the various populations of the four communities were not considered in apportioning the sample size of 160. The rationale for this approach was to eliminate any bias due to sample size differences in the data. Based on this, 40 farming households from each community were simple randomly select and data



regarding the socio-economic characteristics, food availability, food accessibility and access to institutions were obtained for analysis. This sampling technique guarantees that the composition of the sample will be precisely and perfectly representative of the population (Gravetter&Forzano, 2006). In all a total of 160 households responded to the survey. However, due to incomplete and or inconsistent data, 12 households were disregarded. The remaining 148 farming households were included for the data analysis. In summary, the households were selected from the four communities in the Bongo districts. Food consumption data of 148 households were used for the analysis.

### **3.5 Data type and source**

The study collected data from both primary and secondary sources. Primary data was obtained from farming household through the use of structured questionnaire. The structured interview guide was used to collect data on household characteristics such as demographic information (sex, age, level of education, marital status, occupation etc.), farm specific characteristics (livestock types, implements use, types of crops grown, number of hectare and output), food and non-food expenditures, remittances, employment and income, agricultural activities and finally the nature and risks of farming. Secondary data on recommended calorie intake for both children and adults and their respective equivalent ratios was obtained from the Ghana Statistical Service (GSS). Also, the calorie content of some selected crops was also obtained from FAOSTAT (2009) and Kuwornu *et al.*, (2013).



### 3.6 Data Collection instrument

To explore the questions of the research, the study employed two main research instruments namely structured interview guide and questionnaire. [Note: Questionnaires were only used if the respondents was well educated to answer the questions unaided]. This was partly because of the nature of information sought for and also nature of respondents. Admittedly, most of the respondents had primary education and below. The interview was one of the main data collection methods employed to gather primary data for the study. As a method for data collection, interviewing is considered to be very good in gathering knowledge on complex issues (Gravetter&Forzano, 2006). Patton (2005) as well confirmed the above claim by observing that interviews help to capture how the interviewees view their world, to learn their terminology and judgments, and to capture the complexities of their individual perceptions and experiences. Interviewing involves a high degree of proximity to the interview object, and this allows for a flexible approach and makes it possible for rich and detailed information that would not be possible otherwise to be received. Interviews also reduced the incidence of non-response and exercised greater control over the data collection process.

Farming households were visited and interviewed to obtain information on their socio-economic situation. The interview was a face to face interview. This study however adopted a structured interview and this choice was informed principally by its appropriateness for the nature of the respondents. Using structured interview also enhanced the study by providing a sound platform that reduced interviewer bias and



helped attained an appreciable level of objectivity and uniformity in the procedure (Saha, 2005). A total of 160 interview guides were designed with closed and open-ended questions and each interview session lasted for about 45 minutes. The limitations encountered during the interviewing process included error in recording, instruction errors, lack of anonymity among others. These limitations were reduced by taking appropriate measures such as ensuring effective hearing, recording complete responses, avoiding haphazard replacement of responses among others. In order to ensure that these mitigating measures were achieved editing was conducted at the close of each day which allowed for prompt correction and easy call backs where necessary. Codes were also assigned to farming households for easy call back if need be.

### **3.7 The Research Team**

The study sought the assistance of field assistants because of the time and language barrier. The size of the sample was relatively high and therefore demand more time in executing the tasks of data collection from farming households since each farming household was to use an average of 45 minutes. Again, the researcher was not fluent in all the local languages and needed people with that advantage to assist to eliciting information from the respondents. Two assistants, one male and one female were therefore recruited to carry out various roles during the collection and processing of the data. The two assistants were selected based on a number of reasons including their knowledge of the variables under investigation as well as their knowledge of the communities in which data was collected and their ability to speak the language



of the respondents. The research assistants taken through the interview guide for them to be abreast with issues to be investigated before they administered the interview sessions. The assistants were acquainted with the objectives of the study, the type of instrument to be used and the type of information needed. This was done as a measure of ensuring reliable data collection.

### **3.8 Pre-testing of the data collection instrument**

The research instrument was pre-tested on ten farming households in Bolga Nyariga. The purpose of the pre-test was to resolve issues of ambiguities and unnecessary items in the interview schedule. Pre-testing also helps to unearth the face and content validity and reliability of the items on the interview schedule and also ensures that the research is able to measure what he intends to measure. The interview schedule was then amended accordingly for use in the field. The rephrasing of the items on the interview schedule was intended to make the items easy to administer for the farming households to provide the appropriate and consistent responses to the items.

### **3.9 Data Processing and Analysis**

The process for the data analysis included data preparation (coding, editing and checks for errors and biases), counting, (registering research items and frequency of occurrences), grouping of collected data, analyzing and discussing data by cross-tabulations and then test of significance. Data collected were imputed using the Statistical Product for Service Solutions (SPSS) Version 21 software and analysed using STATA version 12.







A descriptive statistics technique was also employed in the study. Frequency distributions and histograms, cross tabulation were used under descriptive statistics. These techniques were considered appropriate to display frequencies and percentages of independent variables (age, educational level and other relevant background information) of farming households and dependent variables.

In this study both parametric and non-parametric statistical techniques were employed. Non-parametric techniques are ideal for this use because; the data were measured using nominal (categorical) and ordinal (ranked) scales, the distribution of the population scores was also not normal, and hence the violation of the assumption of homogeneity of variance. Therefore, a non-parametric technique, the Pearson correlation was applied to measure the relationship between the socio-economic and demographic characteristics of the farming households and household food security status. The primary objective of the Pearson correlation is to determine whether two variables are related or not. The value was calculated using household food security status as the independent variable and various aspects of the farming household as the dependent variables. The probability value was calculated to determine the level of significance. In this test, if the calculated value ( $p$ ) is less than or equal to 0.1, the relationship between two variables is statistically significant. For the parametric technique, logistic regression estimation technique was employed. The unit of analysis is the household level.

### 3.10 Measurement of Food Security

Following Babatunde *et al.*, (2007), Kuwornu, Suleyman, and Amegashie (2013), Food Security Index (FSI) was constructed to determine the food security status of farming households in Veve and its surrounding communities based on the food security line using the Recommended Daily Calorie Required Approach (RDCRA). Farming households whose Daily Calorie Intake (DCI) were equal or higher than Recommended Daily Calorie Required (RDCR) were considered food secure farming households and those whose Daily Calorie Intake were below the Recommended Daily Calorie Required were considered food insecure farming households. The Food Security Index is given as;

$$Z_i = Y_i / R \dots \dots \dots (1)$$

Where  $Z_i$  represents FSI of the *i*th farming household  $Y_i$  is the Actual Daily Calorie intake of the *i*th farming household and R is the Recommended Daily Calorie Requirement of the *i*th farming household. Per Capita Actual Daily Calorie Intake was obtained by dividing daily calorie intake of each farming household by its' household size. Similarly, farming households' Per Capita Daily Calorie Requirement was also obtained by dividing the households' Daily Calorie Requirement by household size. The Ghana Statistical Service (GSS) and IFPRI (2000) standard of 2,900 kcal was used to determine the Daily Recommended Calorie Requirement or food needs of farming households in this study. This daily calorie intake was used it was consistently and widely been adopted in the literature in the estimation of food security. Secondly, for comparison and uniformity sake, it was imperative to follow IFPRI and GSS standard recommended daily calorie intake.



Farming households' composition or daily food requirement (daily calorie requirement) was estimated by first categorizing members of each household into different age groups and this is informed by the fact that different age groups have different calorie requirements or needs. Following GSS (2000), daily energy (calorie) requirements of various household age compositions were converted into adult equivalent using the equivalent scales (see Table 3.1).

**Table 3. 1 Recommended Daily Energy Intake and Equivalent Scale**

Age Category	Average energy allowance per day	Equivalent scale
Children (<6)	1150	0.4
Children (6 -18)	2250	0.7
Adults (> 18)	2900	1

**Source: Ghana Statistical Service (2000); Kuwornu et al., (2012).**

Total farming household composition calorie requirement was obtained by multiplying the total number of adult in each households by the recommended calorie requirement of 2,900kcal (i.e. Total Number of adult\*2900kcal). The total food requirements for children were also converted to adult equivalent. This was done by multiplying the total number of children below the age of six (6) years in each farming household by Recommended Daily Calorie Requirement of 2900kcal and conversion factor of 0.4. Similarly, the total number of children between the ages of 6 to 18 years in each household was also multiplied by Recommended Daily Calorie Requirement of 2,900kcal and a conversion factor of 0.7 to obtain their adult



equivalent. The total Daily Calorie Requirement for each farming household was obtained by summing up the requirement for the three age groups estimated above. The procedure was repeated for Recommended Daily Calorie Requirement of 2,260 kcal (FAO Ghana). Farming Households' daily food consumption (Daily Calorie Intake) was obtained from household own food production and purchases to supplement own food production. The data on actual food consumed (maize, rice, millet and beans) by each household per week was obtained and converted into kilogram. The energy content of 1kg of each foodstuff (maize, millet, rice and beans) was obtained from literature (see Table 3.2).

**Table 3. 2: Foods crops Calorie per kilogram and milling ratios**

Food Crop	Calorie/Kg	Milling Ratio
Rice	3,640	0.65
Maize	3,590	0.85
Millet	3500	0.85
Beans	3432.12	0.85

**Source: FAOSTAT (2010); Kuwornu et al., (2012).**

The total quantity of each food (in kilogram, that is converted from a “bowl or alonka” into kilogram) that is consumed by each household was then multiplied by the energy content (e.g. total kilogram of maize consumed per week \*3590kcal = total kcal of maize consumed). This procedure was repeated for rice, millet and



beans. However, due to processing and grinding losses, the quantity of each food consumed per week was multiplied by the energy content and its respective milling ratio as per the author's construct. As seen in Table 3.2, this study considers the milling ratio pertaining in the literature and as used in previous studies as too high and has the propensity to under estimate Households Actual Daily Calorie Intake. And this will inevitably affect the food security situation in the study area by under estimating it. The justification for not using previous milling ratios is that, they were constructed in the 1960's when machines and other procession equipment were not efficient. However, in recent times, there exit more efficient food processing equipment and therefore processing and grinding losses are expected to be low. The total kilocalories of maize, millet, rice and beans consumed by each household were summed up and divided by 7 to obtain Actual Daily Calorie Intake.

### **3.11 Analysis of the relationship between irrigation and food security**

By taking into consideration of the limitations of this research, essentially because the study is focused on cross sectional and micro-level analysis, this study explored the current status of the irrigation scheme and its contribution to household food availability and food security in the study area. To show linkages between food security status and use of irrigation, an assessment of four major dimensions was carried out. First, total food production from users and non-users of irrigation was also calculated and t-test used to find the significance of irrigation to food production. Since, recorded food produced from farming households do not have the same unit of measurement as given by farming households, their respective market



prices were used to convert them into monetary values. Secondly, the contribution of irrigation in terms of the amount of food energy it provides for the farming households in the study area was also analyzed. Thirdly, the total sampled farming households were categorized into irrigation users and non-users and the household food energy amount in Kcal of these groups were compared using t-test to check whether there is any significant mean difference between users and nonusers to imply any significant contribution of irrigation to farming households food production, availability and security. Finally, a chi-square test was used to test if there is any significant association between food security status of farming households and use of irrigation. A chi-square was used because most of the variables were categorical. A logit model was also used to find out the determinants of food security in the study area. The analyses of these four dimensions were adopted to link irrigation to food security status.

### **3.12 Conceptual Framework**

Irrigated agriculture plays a crucial role for sustainable livelihoods of rural communities and improving food security among farming households. Improvement in access to irrigation water serves as a powerful tool to diversify livelihoods and reduce vulnerability for smallholder producers (Birhanu & Pedy, 2003). There are five key dimensions to how irrigated agriculture contributes to socioeconomic uplift of rural communities. These are production, income, consumption, employment, food security, and other social impacts contributing to overall improved welfare (Hussian, 2004).

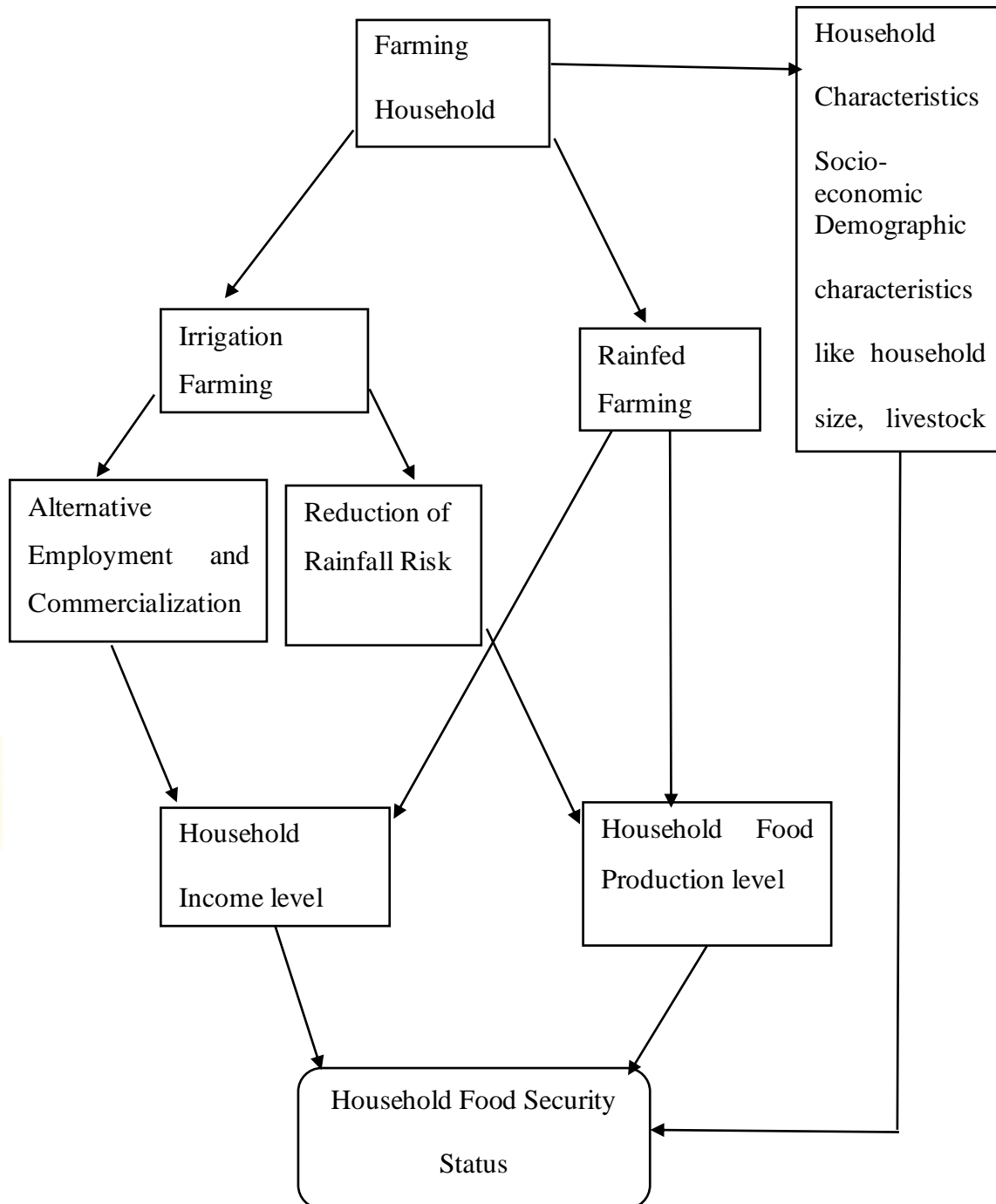


Irrigation can benefit the poor through raising yields and production, lowering the risk of crop failure, and generating higher and year-round farm and nonfarm employment. It can enable smallholder farmers to adopt more diversified cropping patterns and to shift from low-value subsistence production to high value market-oriented production, which increase income of household. Furthermore, Abebaw (2003) the use of irrigation will enable farm households to produce high value crops, in most cases vegetables, which eventually increase crop income. Increased income creates consumption stability since the farmers will have access to purchase enough food for household.

As shown in Figure 3.1, farming households that participate in irrigated agriculture would be able to increase crop production through increased use of complementary inputs (such as high yielding variety seeds, fertilizers, pesticides, etc.), which enables them to produce more and retain food for household consumption i.e. availability of food in household will be enhanced. Access to irrigation also creates an opportunity for rural farm households to produce crop throughout the year since water will be available for crop to grow whenever needed, that means risk of crop failure is reduced. Hence, the household will not face consumption shortfall, as production of crops are possible during off periods where food stocks are depleted. Admittedly, not only irrigation farming can influence household food security status, socio-economic and demographic factors equally imperative determinants of food security.



**Figure 3. 1: The link between household participation in Irrigation farming and household food security status**



Source: Author construct, 2014





### 3.13 Theoretical specification of food security

A number of models of food security status together provide a starting point for the choice of appropriate indicators of food security. Food Security evolves across the entire lifetime of households, however a static model of food security status is discussed in this section. Unlike the case of household health issues, models of the production of food security are still limited. The broad and multidimensional concept of food security might be one of the underlying reasons for the lack of a theoretical model framework of food security (Pangaribowo, Gerber, Torero, 2013). However, as the food security concept is closely associated with health, the food security model presented in this section are derived from the existing framework of health production functions (Schultz 1984, Strauss 1986, Strauss and Thomas, 1998, 2007). The variables involved in the food security models are mostly based on the UNICEF (2000) framework for nutritional status and other health outcomes. Therefore following Strauss and Thomas (2007), a static food security production function is simply specified as

$$FS = f(N, P_{irr}, K, A, \mu) \quad 1$$

Where FS represents food security status. It should be noted that the household food security production function in equation (1) only accounts for the demand side of the food security status, thus assuming food supply as given. This means that this static representation of the household food security status is within the realm of partial equilibrium analysis. This is also in line with the conceptual framework laid out by Hoddinot et al. (2012), in which the household's food security status are the product of the households' intentional action under their specific preferences and constraints.



Household food security status are therefore determined by a set of inputs and behaviors,  $N$ , which includes dietary intake, and also behaviors such as participation in irrigation farming  $P_{irr}$ , and non-farm activities,  $k$ . As for other production functions, the technology also plays an important role in household's food security statuses. Technology as an underlying structure of the food security production function differs across socio-demographic characteristics,  $A$ , including age and gender. As in standard production functions,  $\mu$  represents unobserved characteristics including measurement of errors of covariates and innate or inexplicable food security statuses. From the aforementioned model in equation one, the household demand function for food security inputs and output is specified in the following equation;

$$FS = f(N, P_N, P_{irr}, B, R, K, A, \mu) \quad 2$$

Each demand function varies with FNS inputs and behaviours,  $N$ , input prices,  $P_N$ , demographic characteristics,  $A$ , human capital  $K$  and household characteristics  $B$ , non-labor income,  $R$  and  $P_{irr}$  represents household participation in irrigation farming. However, a strict assumption is made about the input prices, since the farmers mostly eat what they cultivate and have the same market, prices are set to the same for all households and therefore do not vary and hence not considered in the study as a determinant of household food security.

### 3.14 Empirical model specification

According to the UNICEF (2000) framework, food security is not determined by food availability alone, but also by other household characteristics such as human



capital, household size and other factors. Again, as explained earlier, the conceptual framework laid out by Hoddinot et al. (2012) also posits that household food security statuses are the product of households' intentional action under their specific preferences and constraints. Therefore following the theoretical expositions of the conceptual frameworks of UNICEF (2000) and Hoddinot *et al.* (2011), the food security models espoused by Jrad, Nahas, and Baghasa (2010), the empirical studies of Kuwornu *et al.*, (2013), Feleke *et al.*, (2003), Oluyole *et al.*, (2009) and Pappoe (2011) and considering availability and constraints of the data, the empirical model specification for household food security among farming households can be represented as;

$$FSS_i = \alpha + \beta_1 Irrigation_i + \beta_2 X_i + \xi_i \quad 3$$

Where  $\xi$  stands for non-observable attributes and captures the idiosyncratic errors. The matrix of  $X$  includes all control variables and  $i$  represents a farming household in the study area.

### 3.15 Estimation technique

This study applied a probability model specified as a function of series of explanatory variables such as socioeconomic, demographic, institutional and farming characteristics of farming households' heads as elaborated below. The dependent variable is a binary/dummy variable, which takes a value of zero or one depending on whether or not a household is food secure or not (i.e. Food secure = 1 and Food Insecure = 0). Thus, a logistic model is used to estimate the determinants of food security and to assess the probability of a farming household being a food secure or



otherwise. Logit regression analysis is a multivariate technique which allows for estimating the probability that an event occurs or not, by predicting dependent outcome from a set of independent variables. In the food security situation, the dependent variable is a farming household which is food secure or otherwise in relation to the household's head participation in irrigation farming and other household characteristics. The functional form of the linear probability model specified as follows (Gujarati, 2006)

$$P_i = E(Y = 1|X_i) = \beta_1 + \beta_2 X_i \quad 4$$

Where  $X$  is the matrix of food security inputs and  $Y = 1$  means that a household is food secure.

Now consider the following representation of household food security status;

$$P_i = E(Y = 1) = \frac{1}{1 + \exp[-(\beta_1 + \beta_2 X_i)]} = \frac{1}{1 + \exp(-Z_i)} \quad 4i$$

Where  $Z_i = \beta_1 + \beta_2 X_i$

This equation is known as the cumulative logistic distribution function and  $Z_i$  ranges from  $-\infty$  to  $+\infty$ ;  $P_i$  ranges between 0 and 1;  $P_i$  is also a non-linearly related to  $Z_i$  (that is,  $X_i$ ) thus satisfying the two conditions required for a probability model. In satisfying these requirements, an estimation problem has been created because  $P_i$  is nonlinear not only in  $X$  but also in the  $\beta$ 's. This means that one cannot use ordinary least squares procedure to estimate the parameters (Gujarati, 2006).

Hence,  $P_i$  is the probability of a farming household being food secure and is given by

$$\frac{1}{1 + \exp(-Z_i)} \quad 4ii$$

Then  $(1 - P_i)$  is the probability that a household is food insecure and is also given as



$$(1 - P_i) = \frac{1}{1 + \exp(Z_i)} \quad 4iii$$

Therefore,

$$\frac{P_i}{(1 - P_i)} = \frac{1 + \exp(Z_i)}{1 + \exp(-Z_i)} \quad 4iv$$

$P_i/(1 - P_i)$  is the odds ratio in favour of a household being food secure. That is; the ratio of the probability that a household is food secure to the probability that it is not food secure. Taking the natural log of equation (4iv), we have

$$L_i = \ln[P_i/(1 - P_i)] = Z_i = \beta_1 + \beta_2 X_i \quad 4v$$

That is, the log of the odds ratio is not only in  $X_i$ , but also in the parameters.  $L_i$  is therefore referred to as the logit model. This model was used to estimate the probability of a household being food secured.

### 3.16 Justification of the estimation technique

This study employed logistic regression estimation technique as its main estimation technique. A logit model estimation was used as the main estimation technique because the dependent variable food security was measured whether the household is food secured or not. The dependent variable was therefore a binary response variable which takes on the value of 1 if a household is food secure and 0 otherwise, hence, a logistic model was used to estimate the effects of participation in irrigation farming on household food security status. The choice of logit is therefore informed by the nature of the dependent variable and the fact that the main interest of the study is to find out the factors associated with household food security. Logit models guarantee



that the estimated probabilities increase but never step outside the 0 – 1 interval and the relationship between probability ( $P_i$ ) and explanatory variable ( $X_i$ ) is non-linear. Logistics regression model results are easy to interpret and the method simply to analyse (Vasisht, 2012: Wooldridge, 2006). The decision to use logit though a probit model can be used is also based on the fact that the choice between logit and probit according to Vasisht (2012) is a matter of personal preference as both estimation techniques produces similar results. Again, logit models produces statistically sound results by allowing for the transformation of dichotomous dependent variable into a continuous variable ranging from  $-\infty$  to  $+\infty$ , hence the problem of out of range estimates is avoided. Logit models gives parameter estimates which are asymptotically consistent, efficient and normal (Wooldridge, 2006).

### **3.17 Regression diagnostics and post estimations test**

To ensure that estimates from the regression are robust, unbiased and consistent, the data was first observed to deal with influential observations, outliers, missing values and implausible values. The following diagnostics and post estimation tests were also conducted.

#### **3.17.0 Model specification error test**

A logistic regression model is built on the assumption that the outcome variable is a linear combination of the independent variables (Wooldridge, 2006). Hence to ensure the model is correctly specified, the Linktest has to be performed (Chen *et al.*, 2003).





### **3.17.1 Multicollinearity**

Multicollinearity (or collinearity for short) occurs when two or more independent variables in the model are approximately determined by a linear combination of other independent variables in the model. (Wooldridge, 2006; Stock & Watson, 2003). The primary concern is that as the degree of multicollinearity increases, the regression model estimates of the coefficients become unstable and the standard errors for the coefficients can get wildly inflated (Stock & Watson, 2003). Therefore, a correlation matrix was constructed to observe whether there will be strong correlation co-efficient among the explanatory variables.

### **3.17.2 Checking homoscedasticity of residuals**

Following Stock and Watson (2003) and Wooldridge (2006), as a rule-of-thumb, estimation of every model requires an assumption of heteroskedasticity. By default STATA assumes homoscedastic standard errors, so the model was adjusted to account for heteroskedasticity by using heteroskedasticity-robust standard errors to deal with the problem of heteroskedasticity (Ronchetti, 1985). By adding robust to the estimated equation therefore addresses the problem of heteroskedasticity.

### **3.17.3 Goodness-of-fit of the model**

The model fit implies whether the model specified fits the distribution and nature of the data available. One way to check model fit is by the use of log likelihood chi-square. The Hosmer-Lemeshow's goodness-of-fit statistic is computed as the Pearson chi-square from the contingency table of observed frequencies and expected

frequencies. Similar to a test of association of a two-way table, a good fit as measured by Hosmer and Lemeshow's test will yield a large p-value to indicate that the model fits the data (Wooldridge, 2006). This study therefore the log-likelihood chi-square and the Hosmer-Lemeshow's goodness-of-fit statistic computed as the Pearson chi-square.

### **3.18 Justification and measurement of variables**

**Age of the head of household:** It measures age of household head in years. It is therefore a continuous variable. The age of household head is expected to impact on his or her labour supply for food production (Babatunde *et al.*, 2007). Young and energetic household heads are expected to cultivate larger farms compared to the older and weaker household head. As age of household increases, they can acquire more knowledge and experience in farming and pre assume vulnerability and risk conditions of food insecurity. Age of the household also determines the ability to seek and obtain off-farm jobs and income which younger household heads can do better. Arene and Anyaeji (2010) however found older household heads to be more food secure than the younger household heads. Hofferth (2003) argues that the higher the age of the household head, the more stable the economy of the farm household, because older people have also relatively richer experiences of the social and physical environments as well as greater experience of farming activities. Moreover, older household heads are expected to have better access to land than younger heads, because younger men either have to wait for a land distribution, or have to share land with their families. A similar study by Obamiro *et al* (2003)





arrived at a similar conclusion regarding the relationship between age of a household head and household food security. Hence the expected effects of age of household head on food security could either be positive or negative.

**Level of Education of head of household:** It is measured as the highest level of education attained by the household head. Education is a social capital which is expected to have positive influence on household food security. According to Shaikh (2007), the educated individuals have capacity to process and apply the information passed on to them. Lower educational levels impede access to better job opportunities in the labour market, and hamper more profitable entrepreneurship (FAO, 2012). Education is expected to have a positive effect on household food security status. Households' heads with better education level are believed to have a chance to apply scientific knowledge and better manage their farm activities in good manner, hence boost domestic production to fulfil household consumption needs. Level of education of the household head could determine the level of awareness of the possible advantages of modernizing agriculture by means of technological inputs and in turn, would enhance household food supply (Najafi, 2003).

**Household size:** Family labour plays an important role, particularly in rural families as a factor of production. Therefore, household with more agricultural labour results with more profitability in food grain production if available farming land can accommodate household productive labour force appropriately otherwise they will be a burden to the family. Hence, increasing by one household labour has positive





influence in increasing agricultural production and has positive contribution to household food security. However, if the household members do not provide productive labour to the household, an increase in the number of the household members will worsen the food security status. Since food requirements increase with the number of persons in the household and also because land and finance to purchase agricultural inputs are very limited, increasing family size, according to Brown (2004), tends to exert more pressure on consumption than the labour it contributes to production. Thus, a negative correlation between household size and food security is expected (Paddy, 2003) as food requirements increase in relation to the number of persons in a household. Owing to the scarcity of resources, an increase in household size especially the non-working members put pressure on consumption than production (Feleke *et al.*, 2005). An increase in the number of non-working member of household increases the food insecurity level of household (Ojogbo, 2010). The expected effect of this variable on food security is negative. That, if members contribute to consumption demands than production demands, food insecurity is the likely result. Household size is a continuous variable and it is measured by the total number of people in each household.

**Access to Credit:** Credit is very much useful to purchase inputs such as improved seeds and other important inputs. Hence, farmers who have access to credit would have positive effect on crop production due to use of agricultural inputs which enhance food production and ultimately increase household food security status that indicates the direct relationship of credit and household food security. The ability of

household to obtain credit in cash and or in kind for either consumption or to support production are crucial for household food security. Consumption credit increases household's income on the short term basis and could increase the consumption basket of households (Babatunde *et al.*, 2007). Production credit, on the other hand, when obtained on time could increase chances of household to acquire productive resources (seeds, fertilizers, pesticides and others) which will boost production and improve food situation in the house. Access to credit is therefore dummy variable. And the expected effect of access to credit on food security is positive.

**Participation in Non-farm activity:** Off-farm activity is an additional work engaged in by household aside farming to supplement household income. Level of off-farm activity can influence households' food security but this can either be positive or negative depending on the level and gains from the activity (Babatunde *et al.*, 2007). This is because engagement in an activity can bring in money thereby complementing the food security situation of the household. If farmers spend more of their time on off-farm activities at the expense of working on their farm and particularly if the wage they earn does not commensurate with the forgone farm income, their food security situation could be worsened. Therefore, the expected effect on food security could be positive or negative. FAO (1999) also reported that employment in off-farm and non-farm activities are essential for diversification of the sources of farm households' livelihoods. It enables households to modernize their production by giving them an opportunity to apply the necessary inputs, and reduces the risk of food shortage during periods of unexpected crop failures through food



purchases (Devereux, 1993; Maxwell & Frankenberger, 1992). It is a dummy variable measured based upon whether or not the household head has off-farm work. A household head without off-farm work is expected to have a negative food security and a household head with off-farm work is expected to have a positive effect on food security.

**Access to irrigation:** Irrigation, as one of the technology options available, enables small holder farmers to directly produced consumable food grains or/and diversify their cropping and supplement moisture deficiency in agriculture. In doing so, it helps to increase production. It is assumed to have a direct relationship with household food availability and entered the model as a dummy variable. Hence, those household who have access to irrigation was expected to have positive impact on household food security status. Access to irrigation is expected to have a positive relationship with household food security (Burton *et al.*, 2005). Farmers with plots on the irrigation schemes are able to grow crops throughout the year and meet household food requirements than those on dry land farming.

**Quantity of Own farm Production.** This is the total quantity of food and cash crop produced by households from their own farm (measured in kilogram). Cash crops are included based on the fact that they can be sold and money realised from their sale could be used to purchase food for household consumption (Babatunde *et al.*, 2007). The quantity of household own production increases the probability of food security



(Quinoo, 2010; 2009; Pappoe, 2011). Therefore, the expected effect of this variable on food security is positive.

**Farming Experience:** This refers to the number of years household head has engaged in farming. All things being equal, an experienced household head is expected to have more insight and ability to diversify his or her production to minimize risk of food shortage. An experienced farmer is also expected to have adequate knowledge in pest and disease management as well as good knowledge of weather. Research findings revealed a positive relationship between farming experience and food security status (Feleke *et al.*, 2003, Oluyole *et al.*, 2009). The expected effect of this variable on food security is, therefore, positive.

**Donkey/Cattle Ownership:** Donkey/Cattle ownership, measured as a binary response variable, is another determinant of the food security status of households. Donkeys/Cattle in the upper east region serve as a source of traction for many farming households, thereby significantly affecting households' crop production. Animal traction power enables households to cultivate greater areas of land and to execute agricultural operations timely (Govereh and Jayne, 1999). Therefore, a positive relationship between cattle ownership and food security is expected in this study.

**Access to extension services:** Extension service play important role for rural farmers in terms of providing advice and information. Among these, training is one of the



useful service to introduced and develop practices of modern technologies (proper types and rates of fertilizer, improved varieties of seeds, agro-chemicals, etc.) Hence, households that participate in training or farm demonstration organized by extension officers are supposed to apply their knowledge to increase farm production. Thus, households would be in a better position of food security status. This is again a binary response variable measured based on whether the farmer has been visited by any extension officer at least once.

**Remittances:** Remittances has the capacity to cushion households' consumption needs and help alleviate the problems poor farm produce. Households that have access to remittances are therefore more likely to be food secure relative to households that have no access to remittances. The variable is dummy variable measured based on whether the household had received some form of remittances for the period under review.



**Table 3. 3: Variables Description and Measurement**

<b>Variable</b>	<b>Measurement</b>
Farming Experience in years	Continuous
Head of household age	Continuous
Own production	Continuous
Household size	Continuous
Participation in irrigation	Binary Don't participate = 0, Participate = 1
Education of Household head	Categorical No formal education = 0 basic Education = 1 Above basis education = 2
Food security status	Binary Food insecure = 0, food secure = 1
Remittances	Binary Did not receive =0, Did receive = 1
Non-farm activities	Binary Did not participate = 0, Did participate = 1
Access to credit	Binary Did not have access = 0, Did have access = 1
Extension service	Binary Did not have access = 0, Did have access = 1
Donkey/Cattle Ownership	Binary Do not have = 0, Have at least one = 1

Source: Constructed by Author from field survey data, 2014



## CHAPTER FOUR

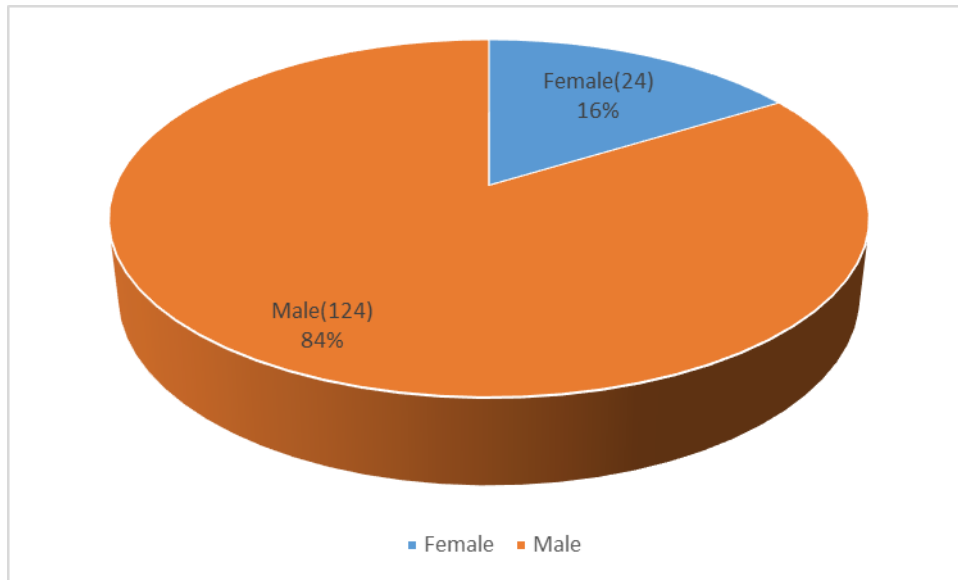
### RESULTS AND DISCUSSION

#### 4.0 Introduction

This chapter presents the results, analysis and discussion of the study. This chapter presented the socio-economic and demographic characteristics of farming households in the study area to enhance the prevailing conditions and predictors of the main research question. Again, bivariate analysis was also done to establish the association between food security and the variables of interest. This chapter ends with regression analysis that revealed the issues of attribution and casual claims among the variables of the study.

#### 4.1 Socio-economic and Demographic Characteristics of the head of Households

**Figure 4.0 Sex distribution of head of households**



Source: Field Survey, 2014





Out of the sampled households, 84.0% (124 households) were male-headed and 16.0% (24 households) were female-headed (see Figure 4.0). This implies that majority of the farming households in the study is male-headed. This finding is constituent with statistics of GSS (2010). The sex of the household head is important for this analysis since in the study only males are heirs to lands and other family assets like livestock.

#### **4.2 Age distribution of the head of households**

According to Romuld and Sandham (1996), young people are more adaptable and willing than older people to try out new innovations since old people believe in their old cultural way of doing things. However, Hofferth (2003) argued that older people have better experiences in agricultural activities than younger people in that they know the social and physical environments better than younger people. It is therefore imperative to analyse the age distribution of households in the study area since it is proven to have bearing on household welfare through their engagement in agricultural activities. As presented in Table 4.0, more than half of the heads of the farming households are above 40 years and just about 12% are between 20-30 years and about 21% are also between 31- 40years. This age distribution may partly be influenced by the influx of the economically active population in these communities into urban areas in search of greener pastures and better livelihoods leaving only the aged population. However, as can be seen on Table 4.0 most of household are headed by people who are economically active and are able to make household farm



decisions as they have acquired more knowledge about farming, as observed by Bembridge (1987).

**Table 4.0 Percentage age distribution of head of households**

Age Distribution	Frequency	Percentage
	<i>F</i>	%
20 - 30yrs	18	12.16
31 - 40yrs	30	20.27
41 - 50yrs	47	31.76
51 - 60yrs	34	22.97
61yrs And Above	19	12.84
Total	148	100

Source: Field Survey, 2014

### 4.3 Marital status of head of households

Marital status was considered in this study because of its important determinant of farming household activities and agricultural production in communal areas. A study by Zenda (2002) revealed that married people are able to share household activities such as agricultural production, herding of livestock, harvesting of fruits, fetching firewood and water. While households with single, divorced and widowed heads have to do all the household activities as they do not have all the support unless from children who are old enough to do some household activities. In the study area, most of the households constitute of married couples followed by widowed families and single and then divorced headed households. Seventy-seven percent of households in the study area are married people, 8.8% are widowed, 8.8% are single headed



household and 3.4% are divorced headed households and only 1.4% of the household heads are separated (see Table 4.1).

**Table 4. 1: Marital status of head of households**

Marital status	Frequency	Percent
	<i>F</i>	%
Single	13	8.8
Married	114	77.6
Divorced	5	3.4
Separated	2	1.4
Widow(Widower)	13	8.8
Total	147	100.0

Source: Field Survey, 2014

*Note: The sample reduced to 147 because of missing value.*

#### **4.4 Level of Educational attainment of the head of households**

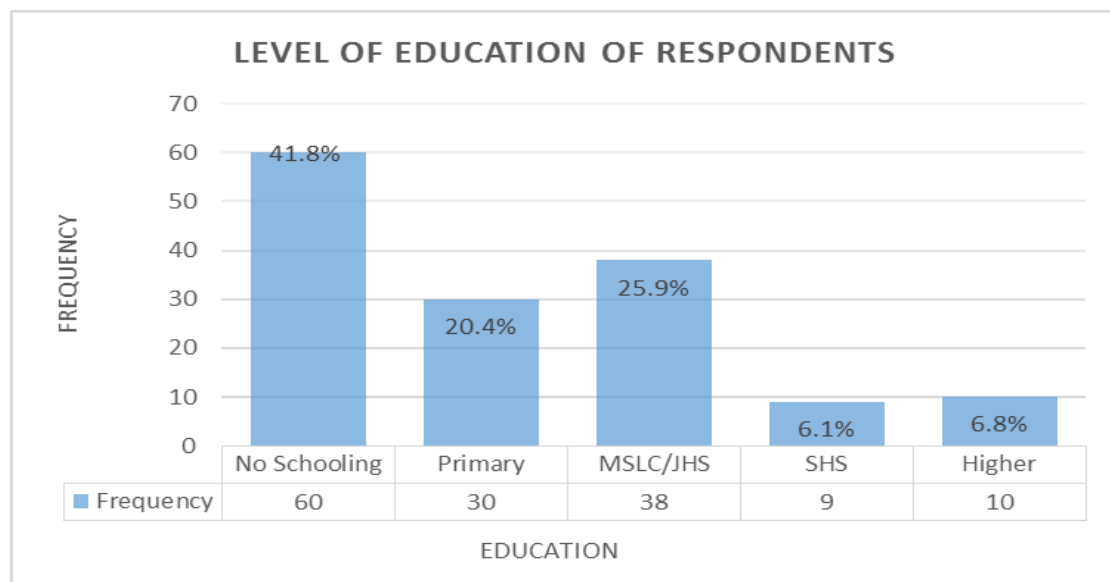
Formal education is one of the important determinants of households welfare and hence food security and increased agricultural production. Education provides the catalyst for information flow and leads farmers to explore as wide as possible, the different pathways into improving their agricultural activities and also helping them to adopt technologies that can enhance their performance on the farms. Especially the use of modern technologies such as use of hybrid seeds, fertilizers and herbicides (Ersado, 2001). Bester *et al*, (1999) also noted that illiteracy is one of the factors that limit economic, social, physical, and technical development in less developed countries more especially the production capacities of small holder farming





households. As seen in Figure 4.1, it can be observed that majority (60 representing about 42%) households heads in the study area had no formal schooling and less than a quarter of the head of households had above junior high level education. Again over 60 percent of the respondent had either no education or primary school level of education. This finding is however consistent with the results of the 2010 Population and Housing Census report. This suggest that educational attainment among farming households in the study area is very low. However, about 7% of head of households had some form of tertiary education.

**Figure 4. 1: Level of educational attainment of the head of households**



Source: Field Survey, 2014

#### **4.5 Household Size and household composition**

The majority of households in the study area are small-scale or subsistence producers with minimal participation in non-farm activities. It has been established that small-

scale farming heavily depends on family labour, therefore the analysis of household size and composition ingredient for the understanding of household food production capacities. A larger household size may mean that a variety of labour capacity is available in the form of young, middle aged and elderly members (Hayes *et al.*, 1997). However, according to (Paddy, 2003), large household size many tend to provide households with the required labour for agricultural production on one hand, while on the other hand larger household size may also put pressure on consumption demand than the labour it contributes to agricultural production. From the study, it was realised that mean household size is 8.3 which is higher than the national average household of size 4.4 and the regional (Upper East) household size of 5.8 (GSS 2010). The household where categorized into small, medium, large and very large households based on categorization from the literature. It was therefore found that, about 39% of the household had medium size while 33% had large size households. It was even intriguing to find that very large sized households (15.5%) were even more than small sized households in the study area as contained in Table 4.2. It can be inferred that most of the households had enough labour to produce because the average household size was about 8.3 people per household.



**Table 4. 2: Percentage distribution of household size of respondents**

Household size	Frequency	Percentage
	<i>f</i>	%
Small [1-4]	18	12.2
Medium [5-8]	58	39.2
Large [9 - 12]	49	33.1
Very Large [13 and Above]	23	15.5
Total	148	100

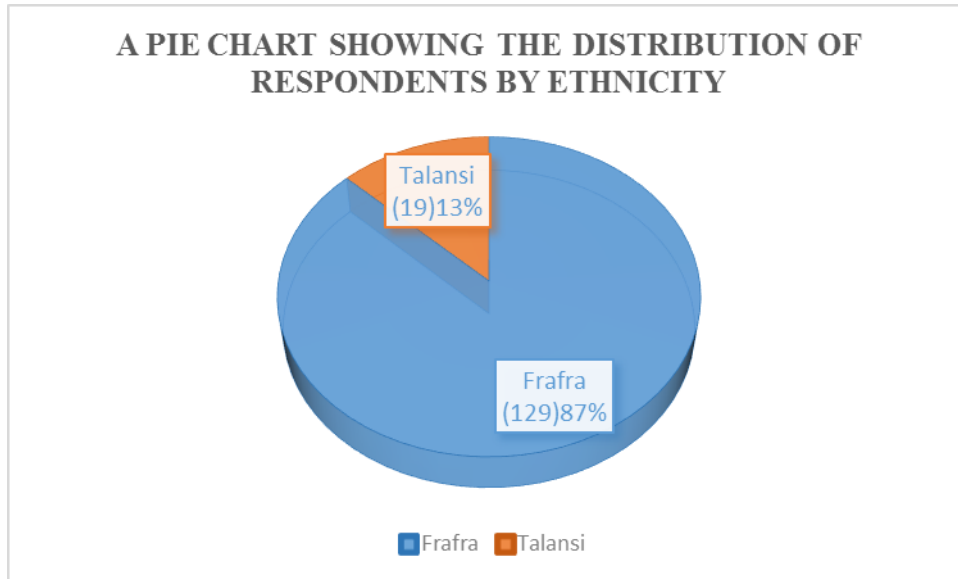
Source: Field Survey, 2014

#### **4.6 Ethnicity**

Ethnicity refers to the ethnic group that a person belonged to. The classification is on sub-ethnic groups in Ghana as officially provided by the Bureau of Ghana Languages and has been in use since the 1960 census in Ghana by the Ghana Statistical Service. Figure 4.2 shows the ethnic affiliation of the households. It indicates that there are only two ethnic groups in the study area of which both are from the major ethnic group of Mole-Dagbani. Frafras was the largest ethnic group (87%) and the rest of the 13% are Talensis. This suggest the study area comprise of indigenous communities which are not flooded with people from other ethnic groups. This also implies that access to land may not be a problem since most of the households are from the same ethnic group and could be potential land heirs or owners.



**Figure 4. 2: Distribution of head of households by ethnicity**



Source: Field Survey, 2014

#### **4.7 Religion**

Thirty two point two percent of the population (32.2%) reported to be Christians (Catholic, Protestant, Pentecostal/Charismatic and other Christian) in 2010, followed by Islam (21.2%) and Traditionalists (24.0%) (Table 4.3). The proportion of people with other religious affiliations is also 22.6%. The distribution of head of households by religious affiliation is somewhat similar to what is reported in the 2010 Population and Housing Census for the Upper East region which has 27%, and about 28% of the people being Muslims and traditionalists respectively. However, in the report, about 50% of the people are Christians comprising all of denominations.



**Table 4. 3: Distribution of Head of Households by Religious affiliations**

Religion	Frequency	Percentage
	<i>F</i>	%
Christianity	47	32.2
Islam	31	21.2
Traditional	35	24.0
Other Religions	33	22.6
Total	146	100

Source: Field Survey, 2014

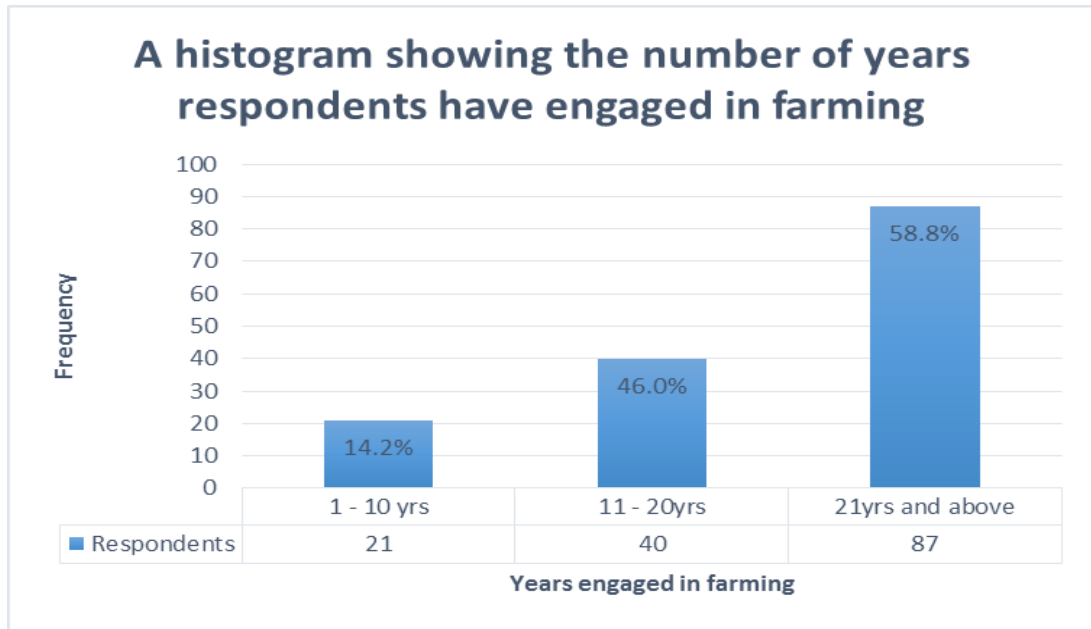
#### **4.8 Farming Experience and Membership of Farmer Based organization**

Farming experience as measured by the years a households has engaged in farming is presented below in Figure 4.3. Majority (58.8%) of the head of households has reported to have engaged in farming for over 20 years while about 14.2% of the respondents have been into farming between 1-10years. This means that most of the households have an appreciable level of experience in farming.





**Figure 4. 3: Distribution of head of households by number of years engaged in farming**

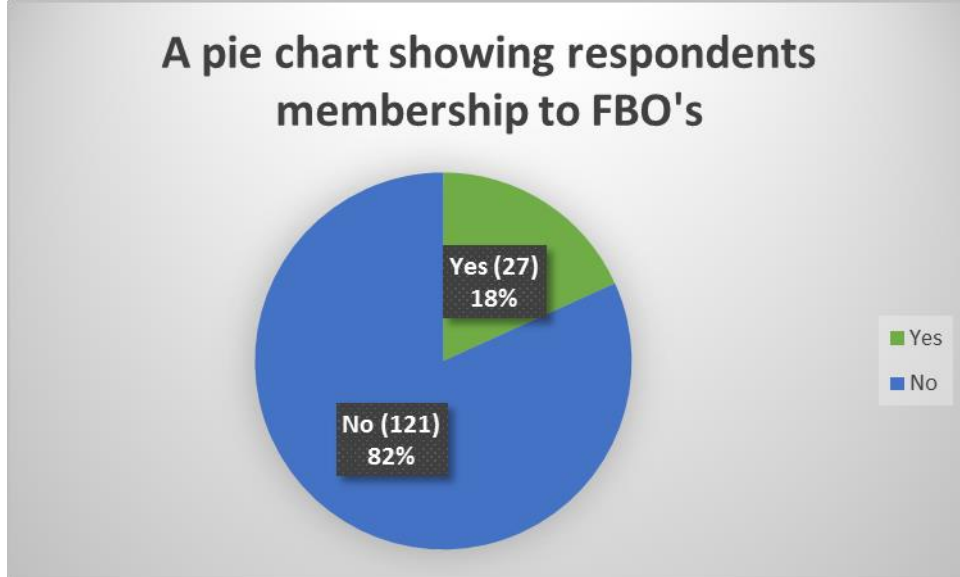


Source: Field Survey, 2014

Farmer Based organizations (FBO's) are mostly formed in farming communities to assist farmers maximize the production efficiencies. Therefore, membership of household heads' to FBO's is an important indicator of agricultural activities and a major conduit for increasing farm yield.



**Figure 4. 4: Head of households' membership to FBO's**



Source: Field Survey, 2014

Many effective FBO's provide their members with agricultural inputs and credits during farming season. In spite of this, only 18% of head of households in the study area are members of FBO's while 82% are not members of any FBO (see Figure 4.4). The study further revealed the reasons why a large proportion of head of households do not belong to any FBO. Among the reasons that were revealed by the respondents, non-availability of FBO's (68.6%) was the much adduced factor followed collapse of FBO's (19.8%). Some farmers did not join these FBO's because they thought they were no benefits to gain from these FBO's (7.4%) and still others said it was waste of time joining these FBO's (4.1%) see table 4.4.



**Table 4. 4: Reasons why famers do not belong to FBO's**

Reasons for why respondents are not members of FBO's	Frequency	Percentage
	<i>f</i>	%
Collapse of FBO	24	19.8
Non-availability of FBO's	83	68.6
There are no benefits from FBO's	9	7.4
Waste of time attending meetings	5	4.1
Total	121	100.0

Source: Field Survey, 2014

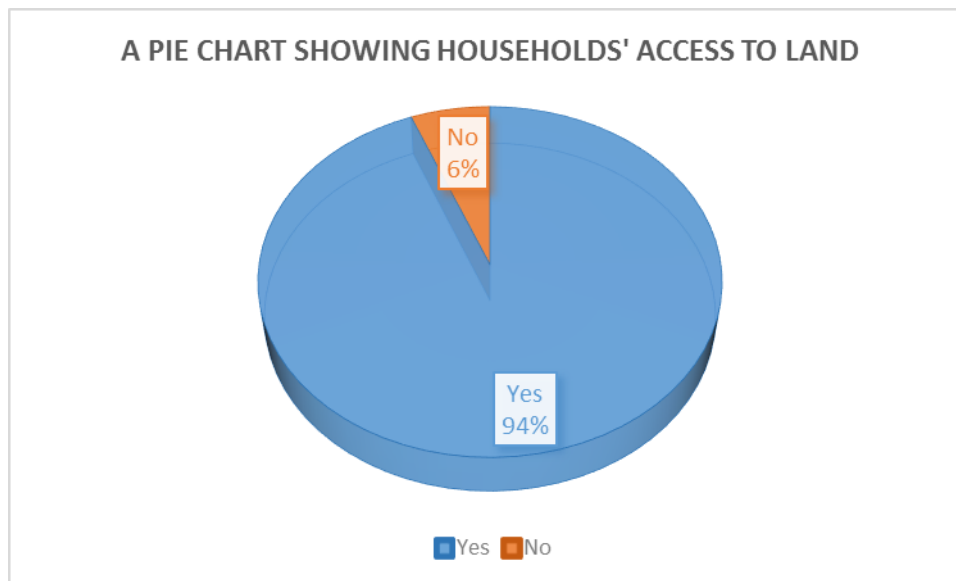
#### **4.9 Access to land, credit and Agricultural extension services**

##### **Access to Land**

Access to land is an important factor that determine farm productivity. Households that have large portions of available land for cultivation has the advantage over households that have limited area for cultivation. Almost all (94%) head of households in the study area reported that they had access to land for cultivation and only 6% of the respondents had no access to land for farming activities (see Figure 4.5).



**Figure 4. 5: Head of households' access to land for farming**



Source: Field Survey, 2014

Whereas an average of 2.8 acres of land is available for households farming activities, only an average of 2.2 acres of land per household was actually cultivated during the 2013 season. Again, whereas 29.1% had less than 2 acres of land available to them for cultivation, as high as 34.5% of household actually cultivated less than 2 acres. This imply that most head of households do not utilize the maximum land available to them for farming activities as seen in Table 4.5.



**Table 4. 5: Access to land by head of households for farm activities**

Land Size	Available Land		Cultivated Land	
	Frequency	Percent	Frequency	Percent
	<i>F</i>	%	<i>F</i>	%
Less than 2acres	43	29.1	51	34.5
2 - 4acres	70	47.3	71	48
4 - 6acres	19	12.8	23	15.5
6acres and above	16	10.8	3	2
Total	148	100	148	100

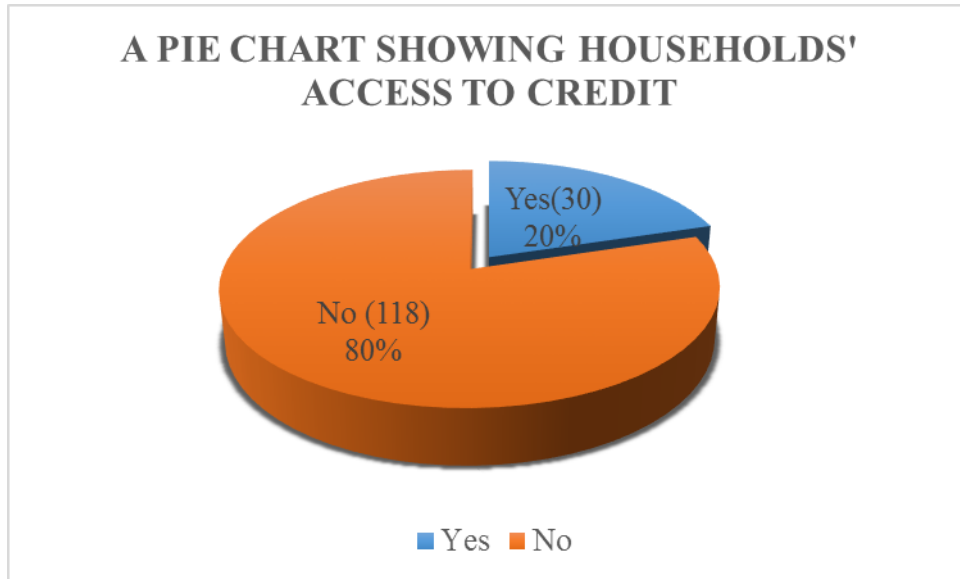
Source: Field Survey, 2014

#### **Access to credit**

Access to credit is critical for household consumption smoothing (Annim et al., 2010) and for farming development among poor households. The ability of households to access credit will enable them supplement their farm produce and credit can also be used to enhance farm works by hiring labour or farm implements. The study however revealed that only 20 percent of the respondents had access to credit through formal financial institutions in the last farming season under review whereas as high as 80 percent had not accessed credit.



**Figure 4. 6: Head of households' access to credit services**



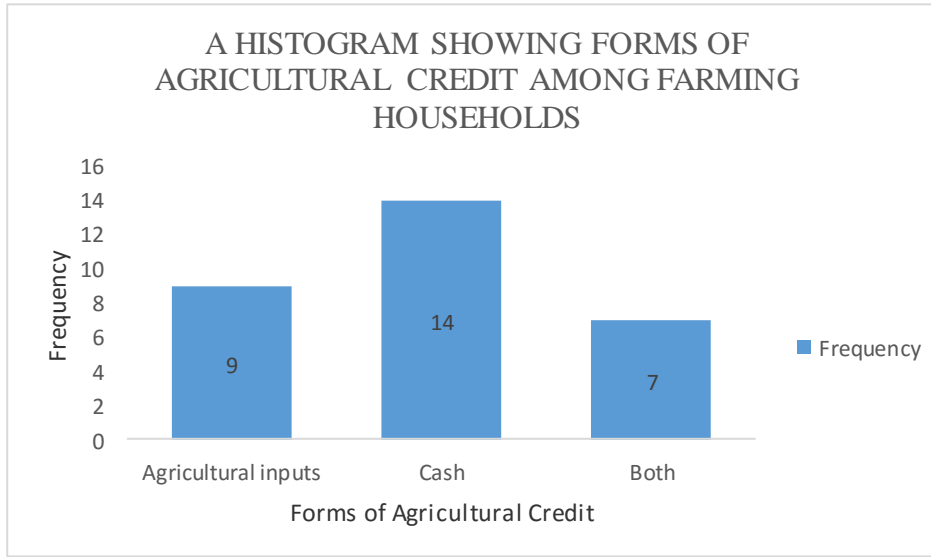
Source: Field Survey, 2014

#### **Forms of agricultural credit**

As shown in Figure 4.7, for the households that accessed credit, majority of them had credit in the form of cash followed by agricultural inputs and some of the households had both cash and agricultural inputs.



**Figure 4. 7: Forms of agricultural credit among farming households**



Source: Field Survey, 2014

**Reasons why farmers do not receive credit**

As indicated in Table 4.6 fear of credit default among farming households accounted for the major (51.7%) reasons why households did not accessed credit. This followed by high interest rate constraint and lack of collateral recording 17.8 percent and 12.7 percent respectively. The respondents also revealed that some financial institutions gives loans to people in groups and since they were not members of these groups, they could not access the credit. Unavailability of credit institutions in the study was also mention as a reason why they did not access credit for the preceding farming season under review.



**Table 4. 6: Reasons why farming households do not receive credit**

Reasons for not receiving credit	Frequency	Percent
	<i>F</i>	%
No credit institution available	7	5.9
No collateral	15	12.7
High interest rates	21	17.8
Did not Request for fear of default	61	51.7
I don't belong to any group	14	11.9
Total	118	100.0

**Source: Field Survey, 2014**

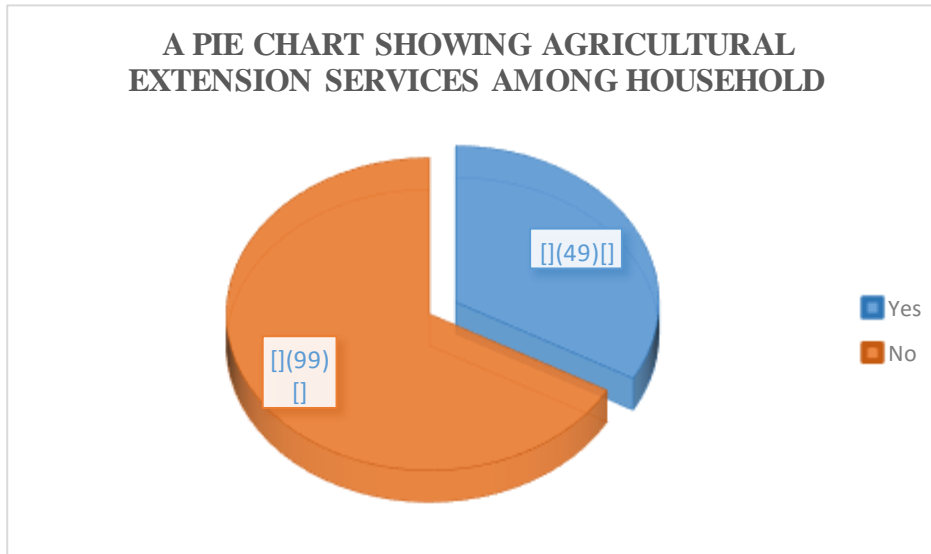
### **Extension service**

Extension services are mostly delivered to interested farmers through sharing of modern agricultural knowledge and information to improve farmers' lives. Thus, they provide technical advices by organizing trainings at Farmers Training Center (FTC) and conducting visits to farmers' fields. As presented in the Figure 4.8 below, only 33% of the sampled households reported that they were visited at least once by an extension officer and 67 % responded that they were not visited by any extension officer for the period under review.





**Figure 4. 8: Access to agricultural extension services among farming households**



Source: Field Survey, 2014

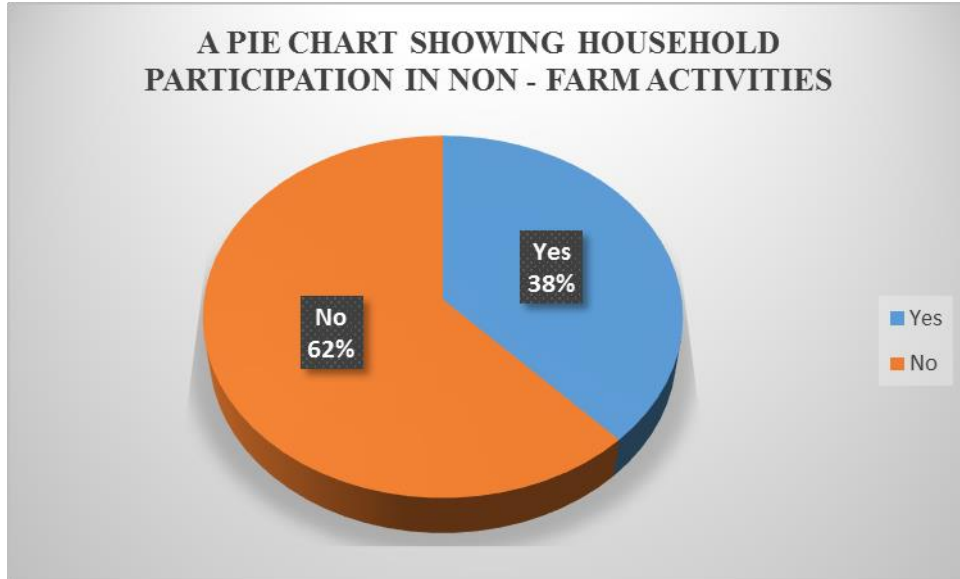
#### **4.10 Non-farm income, Remittances and irrigation farming**

##### **Non-farm activities**

Participation in non-farming activities and non-farm income might be viable alternatives or complementary options for farmers' to support their food demands at household. With this fact, the study found that households' engagement in non-farm income sector was low. Only 38% of the respondents declared that they were involved in non-farming activities in the 2013 season. However, the average amount of income from non-farm activities is GH¢3366.923 (annually).



**Figure 4. 9: Participation in non-farm activities among farming households**



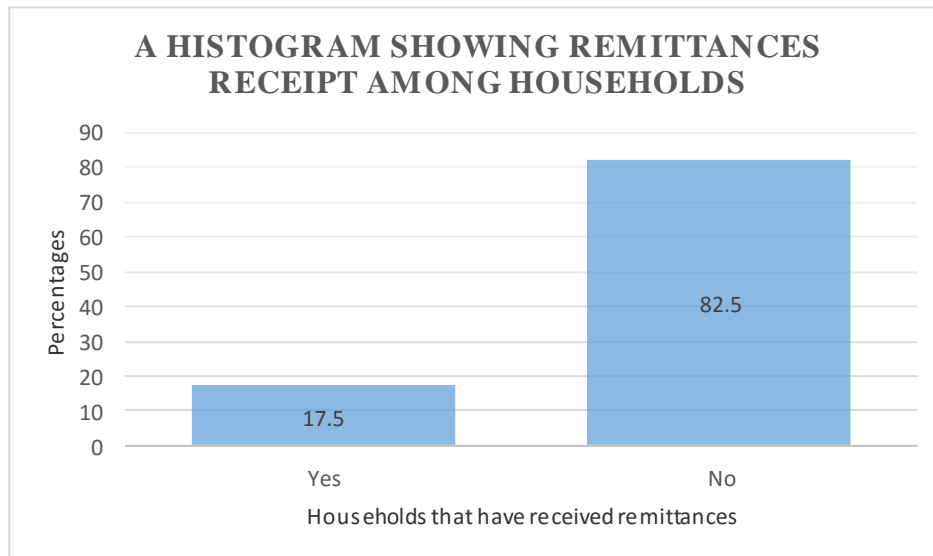
Source: Field survey, 2014

### **Remittances**

Another income source that can ameliorate food security situation among households of farming communities is remittances. According to the Ghana Living Standard Survey report, a good number of household depend on remittances for their livelihood. In this study, only 17.5% percent of households received remittances. The average amount of remittances received was also low (GH¢242.8571 for the year 2013 season).



**Figure 4. 10: Remittances receipt among farming households**



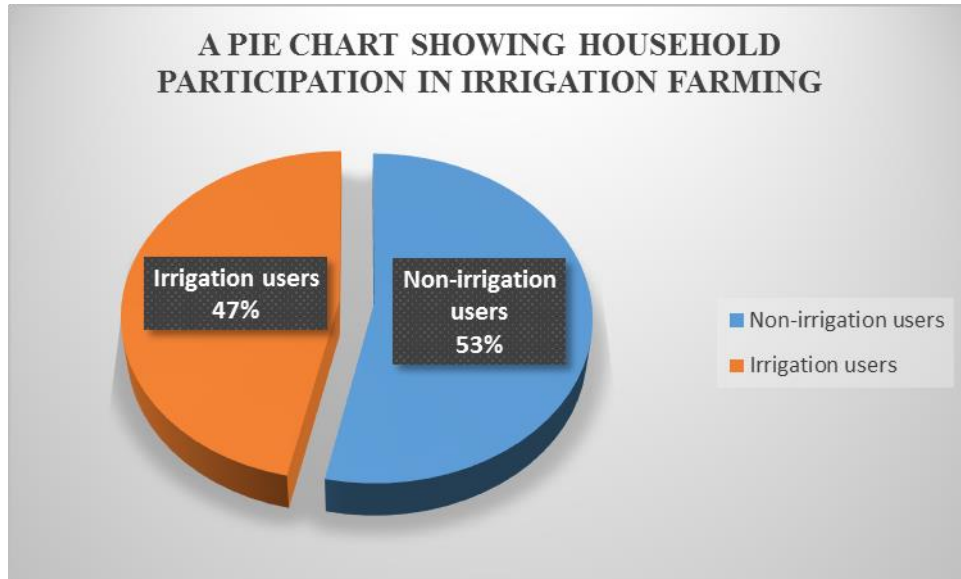
Source: Field Survey, 2014

### **Irrigation farming**

Irrigation farming is major farming activity for head of households in the study area. Irrigation serves as complement to the major rainy season farm produce and also employs a good number of people. As per this study, 47 percent of head of households reported to have engaged in irrigation for the period under review while 53 percent of the households are non-irrigation users.



**Figure 4. 11: Participation in irrigation farming among head of households**



Source: Field Survey, 2014

### **Methods of Irrigation**

Various methods can be used to supply water to crops grown in irrigation farms. Farmers most choose a particular irrigation method is to attain a better crop and a higher yield at farm level. According to sample households' responses, farmers have been practicing two main types of irrigation methods in their farms. A substantial number of farmers (75.4%) practice flooding and 24.6% used furrowing to irrigate the fields. It means that flooding type of surface irrigation is the most widely adapted method of irrigation in the study area.



**Table 4. 7: Irrigation methods and reasons for selection**

Type of Irrigation	Frequency F	Percent %
Furrow	17	24.6
Flooding	52	75.4
Total	69	100

Source: Field Survey, 2014

**Reasons head of households practiced a particular irrigation method**

As to the reasons for their preference to the above mentioned irrigation methods, efficiency in the use of water was the most important reason that informed the choice of the methods. This is followed by slope of the land and type of soil. However, some farmers also consider the nature of the climate.

**Table 4. 8: Reasons for choice of irrigation method among farming households**

Reasons for choice of irrigation method	Furrow %	Flooding %	Total
Slope of the land	5.9	18.5	15.5
Nature of the climate	0	3.7	2.8
Soil type	35.3	9.3	15.5
Use of water efficiently	58.8	68.5	66.2
Total	100	100	100

**Pearson chi-square (3) = 7.8024 Pr = 0.050**

Source: Field Survey, 2014



### Purpose of engaging in irrigation farming

It was also revealed that households engage in irrigation mainly for food provision for their families and to generate income. Only 1.5 percent of the respondents engage in irrigation to provide animal feed for their livestock (see Table 4.9).

**Table 4. 9: Purpose of irrigation farming households**

Purpose of irrigation	Frequency	Percent
	<i>f</i>	%
Generate income	25	36.2
Food provision	43	62.3
Provision of feed for livestock	1	1.5
Total	69	100

Source: Field Survey, 2014

### Crops cultivated in irrigation farming among head of households

As depicted in Table 4.10 the production pattern in the scheme differs considerably by types of crops grown among irrigation users, most of the farmers cultivate vegetables while very few cultivate food crops or cereals and grains. Furthermore, crops from the irrigated agriculture were food crops like Rice and cash crops of Tomatoes, pepper, okra and onion with a proportion of 53.6 %, 78.3%, 46.4% , 40.6% and 11.6% of areas during last year production season respectively. This means that most head of households that engage in irrigation mostly cultivate crops



meant for household consumption and for subsistence and hence majority of the farmers cultivate Tomatoes and rice.

**Table 4. 10: Crops cultivated in irrigation farming**

Crop type	Number of households (f)	Percentage (%)
Tomatoes	54	78.3
Rice	37	53.6
Okra	28	40.6
Kenef/leaves	45	65.2
Pepper	32	46.4
Onions	8	11.6
Maize	4	5.8
Millet	4	5.8
Beans	2	2.9
Groundnut	2	2.9

Source: Field Survey, 2014

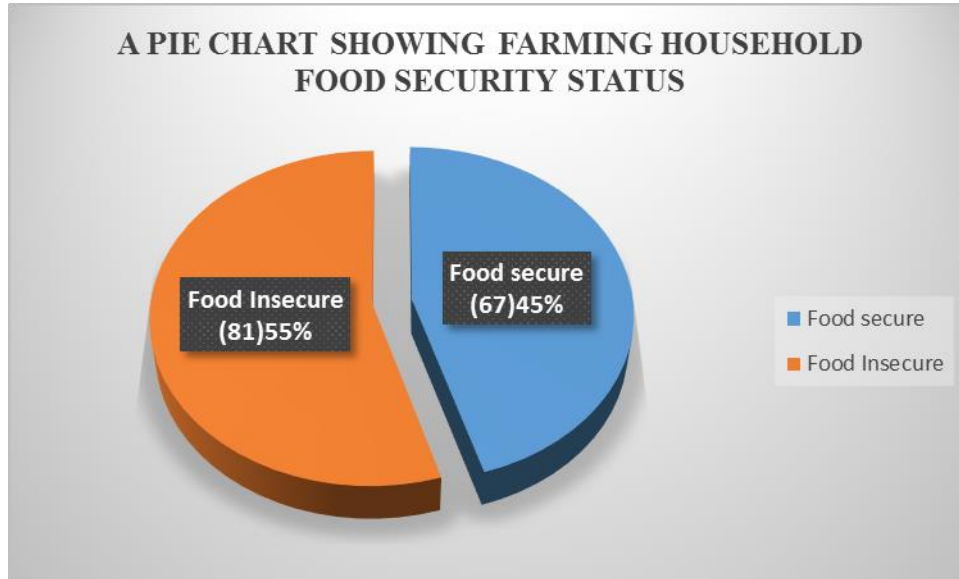
#### **4.11 Food Security status of sample households**

In this study, food security status is measured as the extent of food available for human consumption, expressed in kilocalories per household per day needed of subsistence requirement as elaborated in the above. To this end, an attempt was made to convert food grains available for sampled households into dietary calorie. Thus, households' who were found to fall above the minimum recommended daily calorie requirement level were categorized as "food secure" and those found below the requirement as "food insecure". This implies that more than half of households living in and around Veia community are food insecure. Accordingly, the food security



status of the households sampled using food security index shows that about 45 percent (67 households) were food secure whereas about 55 percent (81 households) are food insecure (see Figure 4.12).

**Figure 4. 12: Food security status of farming households**



Source: Field Survey, 2014

The mean food security index of food secure households was found to be 1.49 and food insecure households were also found to be 0.73. The food insecurity gap implies that on average the food insecure households consumed 27% less than their daily calorie requirements whilst food secure households consumed 49% in excess of their daily calorie requirements. Per capital daily calorie requirement was estimated to be 2,560.8kcal which is lower than the national weighted average of 2,849 kcal (World Food Program, 2009) but higher than head of households in the forest belt of the central region of Ghana which is estimated as 2275kcal ( Kuwornu et al.2013). (See Table 4.11).





**Table 4. 11: Food security status of head of households in Veia**

Item Description	Food Secure	Food Insecure
Percentage of Households	45.3%	54.7%
Mean (FSI)	1.49	0.73
Standard deviation	0.46	0.20
Food Insecurity gap/Surplus Index	49.00%	27%
Per capita Daily Calorie Allowable	2560.8	

**Source: Field Survey, 2014**

#### 4.12 Food grain availability from rainfed and irrigation in the study area

According to FAO (2006) the use of small-scale irrigation has the propensity to increase the availability of food and earning capacity of poor farming households in developing countries. Table 4.12 well underpin the findings of the survey. The t-test verified that there is a significance mean difference in mean food crop production between users and nonusers at 1% significance level. This means that food production and availability for households that engage in irrigation farming is higher than households that do not engage in irrigation farming in the study area.

**Table 4. 12: Food crop production among users and non-users or irrigation**

Variable	Obs	Mean	Std. Err.	Std. Dev.
Non-users	79	979.18	72.7106	646.266
Users of irrigation	69	4634.64	831.158	6904.12
Combined	148	2683.41	416.059	5061.58
Difference		-3655.5	780.28	

Source: Field Survey, 2014

*Note: Difference = mean (Non-users) – mean (Users of irrigation), t = -4.6848, degrees of freedom = 146, Ho: diff = 0, Pr (|T| > |t|) = 0.0000*



*Note: Two-sample t test with equal variances assumption, however, even when equal variances assumption is not invoked by using Welch's degrees of freedom, the results are not significantly different.*

#### **4.13 Comparison of energy acquisition by irrigation users and nonusers groups**

Another way of assessing contribution of irrigation to food security is through comparing irrigation users and non-users in terms of their food energy obtained by their respective food source. Clearly, the survey indicates that there is better food energy availability for irrigation users than non-users. That means a daily average of 3158.47 kcal was supplied for irrigation users while it was 2038.85 kcal for the non-users. (Table 4.13). The t-test verified that there is a significance mean difference in mean food calorie acquisition between users and nonusers at 5% significance level. This means that food energy supply for households that engage in irrigation farming is higher than households that do not engage in irrigation farming.

**Table 4. 13: Food energy obtained by users and non-users of irrigation**

Group	Obs	Mean	Std. Err.	Std. Dev.
Non-users	79	2038.85	149.84	1331.81
Users of irrigation	69	3158.47	473.061	3929.54
Combined	148	2560.84	238.21	2897.95
Difference		-1119.6	470.099	

Source: Field Survey, 2014

*Note: Difference = mean (Non-users) – mean (Users of irrigation),  $t = -2.3817$ , degrees of freedom = 146,  $H_0: diff = 0$ ,  $Pr (|T| > |t|) = 0.0185$*





#### 4.14 Bivariate analysis

##### Irrigation farming and Food security

In connection with the relationship between irrigation farming and food security, the survey result shows that 65.2 % of food secure households were found to be users of irrigation whereas 27.8% were non-users. Parallel to this concerning food insecure household, 34.8% were users and 72.2% were non users. The chi-square result confirmed also a significance association between users of irrigation and food security status at 1% significance level. This finding is so important since it shows that access to irrigation is one of the factors that influences household's food security in the study area. This might show that an irrigation user can cultivate either a range of crops or increase in volume of production of crops in the irrigated agriculture; hence it contributes to ensure household food security especially in areas that are vulnerable to drought. But it is hard to believe that they are consistently food secure since the survey shows that some of irrigation users were food insecure.

**Table 4. 14: Relationship between household participation in irrigation farming and food security status**

Participation in Irrigation	Food secure		Food Insecure	
	<i>F</i>	%	<i>F</i>	%
Non-irrigation Users	22	27.8	57	72.2
Irrigation Users	45	65.2	24	34.8
Total	67	45.3	81	54.7

Pearson chi-square (1) = 12.1363 Pr = 0.008

Source: Field Survey, 2014

#### 4.15 Education and household food security status

It was envisaged that household food security and education status of the household head has positive relationship. In contrast to this, the survey result shows that there is no systematic relationship between educational status of household head and food security status as shown in Table 4.15 This means that household heads level of education is not significantly related to food security status in the study area. This can be explained from the fact that majority of the households has no formal education and as such their food security status would not depend on their level of education. This is because there is no significant variation in educational achievement among head of households and as such cannot explain the variation in food insecurity among these households.

**Table 4. 15: Relationship between household educational attainment and food security status**

Level of education	Food secure		Food Insecure	
	<i>F</i>	%	<i>f</i>	%
No schooling	19	31.6	41	68.4
Primary	13	43.3	17	56.7
MSLC/JHS	17	44.7	21	55.3
SHS	5	55.56	4	44.44
Higher	8	80	2	20

Pearson chi-square (4) = 1.1363 Pr = 0.198

Source: Field Survey, 2014



#### **4.16 Access to credit and households food security status**

Extant literature have recognized that an appropriate application of modern farm inputs such as chemical fertilizers, improved seeds and herbicides would increase crop yield and productivity in smallholder farming system Degefa (2006). Therefore, the importance of inputs is certain for highly degraded environmental context to improve land productivity and make better agricultural production. One way where poor households' farmers can acquire these farm inputs is through credits facilities. The availability of agricultural credit to subsistence farmers is therefore a key indicator in assessing the food security situation of certain target community. Hence, the study examined the relationship between credit service and food security status among farming households in the study area. As contained in Table 4.16, the study result disclosed that there is a significant systematic association in terms of food security status among respondents and access to agricultural credit at 5% level of significance. Whereas 86.7 percent of the households that had access to credit are food secured, only 34.8 percent of the households that could not access credit are food secured. However, the food insecure households, 13.3 percent and 65.3 percent are households that had access to credit and households that could not access credit the period under review respectively.



**Table 4. 16: Relationship between household’s access to credit and food security status**

Access to credit	Food secure		Food Insecure	
	<i>F</i>	%	<i>f</i>	%
Yes	26	86.7	4	13.3
No	41	34.8	77	65.3
Total	67	45.27	81	54.73

Pearson chi-square (1) = 7.0441 Pr = 0.071

Source: Field Survey, 2014

#### **4.17 Donkey/Cattle ownership and household food security status**

Like most parts of the Upper East region, Donkey/Cattles are the engines for agricultural works in the study area. Donkey/Cattles might be used as a means to get additional benefits either in food or cash as they sometimes used for transportation purposes. Ownership of at least one Donkey/Cattle may allow a farmer to prepare personal farming land on time and may rent-in the Donkey/Cattle to other households on a contractual basis in return gets additional income which may supplement their household sufficiently. In general, the survey result manifest that (30.4%) have at least one Donkey/Cattle to plough their land and for other activities. Furthermore, the survey result reveals that there is a systematic association between food security status and household Donkey/Cattle ownership at 10% level of significance as seen in Table 4.17 whereas 35.6 percent of the household that have Donkey/Cattles are food insecure, 62.7 percent of the households that do not have



Donkey/Cattles are food insecure. This may however suggest that Donkey/Cattle ownership related to food security in the study area.

**Table 4. 17: Relationship between household Donkey/Cattle ownership and food security status**

Donkey/Cattle Ownership	Food secure		Food Insecure	
	<i>F</i>	%	<i>F</i>	%
Yes	29	64.4	16	35.6
No	38	37.3	64	62.7
Total	67	45.27	81	54.73

Pearson chi-square (1) = 3.6264 Pr = 0.08

Source: Field survey, 2014

#### 4.18 Household size and food security status

Labour is one of the major resource on which the farming activities of the study communities. Households with large numbers can therefore produce enough labour for farming activities or depending on its composition puts pressure on consumption demands than production capacities of the households. The results shows that large households are significantly associated with food insecurity at 5 percent in the study area as in Table 4.18. Thus, there is a negative relationship between household size and food security. Households that are big have more people to feed than small households and this corroborates the findings of Paddy (2003).



**Table 4. 18: Relationship between household size and household food security status**

Household Size	Food secure		Food Insecure	
	<i>f</i>	%	<i>f</i>	%
Small [1-4]	12	66.70	6	33.33
Medium [5-8]	31	53.50	27	46.60
Large [9 - 12]	19	39.58	29	60.40
Very Large [13 and Above]	4	22.20	14	77.80
Total	66	46.5	76	53.5
Pearson chi-square (3)= 9.2564	Pr = 0.026			

Source: Field survey, 2014

#### **4.19 Participation in non-farm activities and household food security status**

Most of the people in the study area had no access to off-farm work. From the 148 households sampled, 30 household heads had participated in off-farm activities while the rest of the households did not. About 63% percent of those who had participated in off-farm activities were food secure while 37.7% were food insecure. Similar to households that did not engage in any non-farm activities, 40.7 % and 59.3% of these households were food secure and food insecure respectively. This relationship is said to be significant following the Pearson chi-square of 4.9550 with the corresponding probability value 0.008.





**Table 4. 19: Relationship between non-farm activities and household food security status**

Participation in Non-farm activity	Food secure		Food Insecure	
	<i>F</i>	%	<i>f</i>	%
Yes	19	63.30	11	36.70
No	48	40.68	70	59.32
Total	67	45.27	81	54.73

Pearson chi-square (1) = 4.9550 Pr = 0.008

Source: Field survey, 2014

#### 4.20 Remittances and household food security status

Remittances might be alternative options for farmers' to support their food demands at household. Remittances can help households in meeting critical cash and food deficits and also enables them not reduced in grain or livestock thereby preventing undesirable leakages in their household resources (FAO, 2012). However, only 9.5% of sample respondents declared that they have received some form of remittances. The results in Table 4.20 shows however that there is no significant association between remittances and household food security status judging by the Pearson chi-square value of 0.8797 with the corresponding probability value of 0.348.



**Table 4. 20: Relationship between remittances and household food security status**

Remittances	Food secure		Food Insecure	
	<i>F</i>	%	<i>f</i>	%
Yes	8	57.10	6	42.90
No	59	44.00	75	56.00
Total	67	45.27	81	54.73

Pearson chi-square (1) = 0.8797 Pr = 0.348

Source: Field survey, 2014

#### **4.21 Membership of farmer based organisation and food security status**

Farmer based organizations provide support to farmers who are members both in cash and kind. FBO's are vessels through which members get some form of social capital and with the advent of flourishing financial institutions, farmers need sometimes to belong to a group to qualify for loans. FBO's therefore can provide the avenue to improve farm efficiency and productivity and hence reduce food insecurity (Brown, 2004). This study however reveals that there is no significant relationship between food security and household's FBO's membership status in the study area. As shown in Table 4.21, food insecurity is high among households that do not belong to any FBO.



**Table 4. 21: Relationship between household membership to FBOs and household food security status**

Membership of FBO's	Food secure		Food Insecure	
	<i>F</i>	%	<i>f</i>	%
Yes	20	57.10	15	42.90
No	47	41.60	66	58.40
Total	67	45.27	81	54.73

Pearson chi-square (1) = 3.6080 Pr = 0.11

Source: Field survey, 2014

#### **4.22 Extension services and food security status**

Extension officers provide support services to improve their efficiency and productivity. Farmers who are visited by extension officers are more likely to improve their yield since they are mostly advice on best farming practices and farm management (MoFA, 2008). However, this study revealed that there is no significant relationship between contact with extension services and household food security as presented in Table 4.22.



**Table 4. 22: Relationship between extension services and household food security status**

Extension Service	Food secure		Food Insecure	
	<i>F</i>	%	<i>F</i>	%
Yes	22	57.90	16	42.10
No	45	40.90	65	59.10
Total	67	45.27	81	54.73

Pearson chi-square (2) = 3.9705 Pr = 0.13

Source: Field survey, 2014

#### **4.23 Multivariate Analysis: Econometric analysis of Irrigation and household food security status**

To determine the effect households' irrigation and other control variables on farming household food security status, a logistic regression was used. The household socio-economic characteristics were regressed on food security indices and the results presented in Table 4.23. However, before the logistic regression models were interpreted, a number of assumptions had to be satisfied and post-estimation tests conducted so that consistent, reliable, unbiased estimates are produced. After observing the distribution of the data, robustness checks were also conducted as specified in the methodology in Chapter three.

#### **4.24 Robustness check and post-estimation results**

A number of robustness checks were employed to ensure consistency in the regression estimates. Consistent with regression diagnostics, the correlation matrix of the



explanatory variable was first examined. It shows that the regressors are not strongly correlated hence the variables were included in the model. The correlation matrix is presented in Appendix B. Following Stock and Watson (2003); Wooldridge (2006), the Robust command was added to the estimated equation to address the problem of heteroskedasticity. With a p-value of 0.33, the Hosmer and Lemeshow's goodness-of-fit test indicates that the model fits the data well. For model specification test, the linktest was also conducted and the results indicated that the model was correctly specified (the Probability value from the Linktest = 0.881, this means that we fail to reject that the model is correctly specified). The value of Pearson Chi-square test shows the overall goodness of fit of the model at less than 1% probability level. The maximum likelihood estimate of the parameters and the effect of independent variables on the food security status of sampled households were analyzed and presented in Table 4.23

The result showed four variables namely; participation in irrigation farming, access to credit, Donkey/Cattle/cattle ownership, and participation in non-farm activities as relevant and significantly influencing food security status of farming households in the study area. However, whereas household size, and access to extension services, showed negative but significant relationship with food security, all the other significant variables had positive relationship with food security.

It is important to control for other determinants of household food security besides the variables of interest. The choice and specification of control variables is closely



informed by recent empirical research of Kuwornu, Suleyman, and Amegashie (2013), Oluyole, Oni, Omonona, and Adenegan (2009). Babatunde, Omotosho and Sholotan (2007), Shaikh (2007), and Feleke, Kilmer and Gladwin (2003). It is important to also note that selecting controls variables with data available is one way to handle model and data constraints endemic to econometric research (Megginson and Netter, 2001).

Even though some of the control variables were not statistically significant in explaining household food security situation in the study area, they are worth discussing. One of such variable is the level of education of the household head. As expected it had positive influence on household food security but was insignificant. This finding is consistent with the study of Kuwornu et al. (2013) which found similar results among farming households in the Central region of Ghana. The reason why education was not found to be significant is that, over 60% of the sample population had no or primary education and as such education does not vary much among respondents and cannot therefore significantly explain differences in food security status among the farming households.

Farming experience and household own production capacity were also expected to significantly influence household food insecurity among farming households. However, consistent with other studies like Shaikh (2007) and Feleke, Kilmer and Gladwin (2003), these variables satisfied the expected relationship but were not significant. For instance, it was also expected that since some adult members farming





households in the area are most likely to migrate to the cities during the off season, they would remit significantly to offset food shortages. However, the study revealed that remittances do not significantly improve household food security status in the study area. Age of household head is also negatively related to household food security status as expected but is statistically insignificant. This finding is in variant with the exposition of Babatunde et al. (2007) that young and energetic household heads are expected to cultivate larger farms compared to older and weaker household head. The ability to seek and obtain off-farm jobs and income is also predominant among young households' heads in farming communities relative to older heads. Interesting however, Arene and Anyaeji (2010) also found households with older heads to be more secure than households with younger heads. Again this findings corroborates the evidence of kuwornu et al. (2013) who also found negative but insignificant relationship between age of household head and food security. Farming households' access to extension services was also expected to significantly improve food security situation in the study area. However the results showed otherwise even though the a priori sign was met. This result corroborates the evidence of Hasnip, Walmsely et.al. (2001) but in contrast with the study of Ayalew (2003)

**Table 4. 23: Determinants of household food security in Veve and surrounding communities (odd ratios)**

Explanatory Variables	Odds		z- statistic	P>z
	Ratio	Std. Err.		
Participation in irrigation [No]	0.831	0.043	2.520	0.012
Education [No education]				
Basic Education	1.625	1.629	0.480	0.628
Above Basic Education	1.561	0.803	0.400	0.686
Household Size	2.888	0.050	-2.130	0.033
Remittances [No]	1.272	1.102	0.280	0.781
Participation in Non-farm activities [No]	0.361	0.211	1.740	0.082
Access to credit [No]	0.892	0.046	2.190	0.028
Access to extension services[No]	0.981	1.867	1.740	0.181
Farming experience	1.794	1.216	0.860	0.388
Own production Donkey/Cattle/cattle	1.001	0.000	1.580	0.114
Ownership[No]	0.901	0.054	1.730	0.084
Household head's age	0.962	0.050	-0.740	0.460
Constant	0.199	0.271	-1.190	0.235

Source: Computed from Field survey, 2014

*Number of observation = 145      Wald Chi-square (5) = 10.34*

*Prob> Chi-square = 0.0661      Pseudo R-square = 0.3656*

*Log pseudo likelihood = -49.667829*





#### **4.25 Participation in irrigation farming as determinant of household Food security status**

The model measures the influence of participation in irrigation on household status of food security in the study area. This variable positively influenced the food security status of the households. Irrigation was found to be significant at 5% level meaning that irrigation plays a major role in enhancing food security in communal areas. The study therefore revealed that, relative to non-users of irrigation, households that practice irrigation farming are 0.831 more likely to be food secure, all else equal. The results confirmed that irrigation is significant in ensuring that households achieve food security. This can be justified by the fact that irrigation farmers will improve in their agricultural production quantities since they can grow food crops for a minimum of twice a year. So, farmers that participate in irrigation will overcome food insufficiency resulting from a relatively long off-season. This results corroborates with the evidence of a number of studies. Kumar (2003) explained that, irrigation has significantly contributed to boosting India's food production and creating grain surpluses used as drought buffer. Hussain *et al.* (2004) confirmed this by espousing that, access to reliable irrigation water can enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming. The work of Hussain *et al.* (2004) is further elaborated by Woldeab (2003) who also identified that irrigated agriculture has benefited some households by providing an opportunity to increase agricultural production through double cropping and by taking advantage of modern technologies and high yielding crops that called for intensive farming.



However, realizing the full potential, irrigation requires not only a good irrigation (water) supply but also a range of complementary agricultural and institutional support (for example, improved agricultural research and extension). Despite the huge investments, the performance of some small-scale irrigation schemes has been poor and the goal of achieving food security has not been realized (Bembridge, 2000). Also with irrigation schemes, there is a tendency to produce cash crops and these are sold so that they can generate income for the households.

#### **4.26 Donkey/Cattle ownership as a determinant of household food security status**

Donkey/Cattles are among the most important factors of production in agriculture and as it was expected to significantly and positively influence household food security status of the study area. It is the fact that a Donkey/Cattle is major input of draft power for land preparation in crop farming system. Hence, it has significant contribution in supplying of food grain for the household member. In agreement with prior expectation, household head's Donkey/Cattle ownership affects household's food security positively at a probability level of 10%. All other things being equal, households that own at least one Donkey/Cattle were found to be 0.901 times more likely to be food secure relative to households that do not own a Donkey/Cattle. The more the number of Donkey/Cattles available to households the larger is the probability of the household to be food secure. The positive sign of this variable indicates that the contribution of Donkey/Cattle ownership towards ensuring food security. In communal areas, Donkey/Cattles can be used to execute farm operations



on time such as ploughing and applying manure to fields. Farmers with Donkey/Cattles can rent out cattle to their neighbours in peak periods of cultivation in communal areas to get some extra cash. Govereh and Jayne (1999) in a similar study espoused that cattle are used as traction power which enables households to cultivate larger pieces of land and to execute agricultural operations timely. Cattle can also be sold in times of drought to mitigate household food insecurity.

#### **4.27 Household size as a determinant of household food security status**

Household size has a negative and significant effect on the probability of a farming household to be food secured at 5% significance level. All other factors being equal, a per unit increase in household size will decrease the probability of the household becoming food secure by 2.888. It thus means an increase in household size would inevitably mean more people to feed and with the low outputs produced in the fields, thus food availability required by an individual to live a healthy and active life will be overstretched. This implies that the probability of food security decreases with increase in household size. An increase in household size reduces the chances of a household being food secure. This findings is in convergence with Paddy (2003) who found that as a household becomes larger food insecurity increases. Although it is expected that an increases in household size increases the labour requirements, Frankenberger (2002) and Flores (2004) findings showed that households with more people exert more pressure on food than the labour it contributes to agricultural production.



#### **4.28 Access to credit as determinant of household food security status**

This is one of institutional factor that determine food security situation of farm households. The logit model analysis revealed that credit has a negative but significant relationship with food security status (at a probability level of 5%). This is in agreement with the prior expectations about the impact of access to credit services household food security status. This is because farming households that have access to credit can overcome their financial constraints and can purchase various agricultural inputs (improved seeds, farm implements and chemicals) required for their farm production to produce more for household consumption since most of these head of households are peasant farmers. This could also be expected since credit serves as consumption smoothing mechanism which gives households temporal relief against the effects of food insecurity. The result of the study implies that household that received credit had greater chances of being food secure compared to those who did not have credit, all things being equal. Households with access to farm credit have possibility to reduce the probability of being vulnerable to food insecurity. The probability that a household that have access to farm credit would be food secured increases; other things remain constant, by a factor of 0.892 relative to households that do not have access to credit. The result of the study is in line with the findings of Pappoe (2011), who found that access to credit improves the food security status of farming households among biofuel producers in the Central Region of Ghana. The work of Kuwornu et al., (2013) on farming households in the forest belt of the Central region also corroborates this finding.



#### **4.29 Participation in non-farm activities as determinant of household food security**

This variable represents the involvement of the household head in off/non-farm activities and utilized the generated income in cash or in kind to complement household food consumption during the year. Empirical findings indicate that off-farm/non-farm income have effect on food security. In the areas, where the farmers face crop failure, the benefit earned from off-farm activities is an important means of supplementing household food requirements. The result therefore suggests that households engaged in off-farm activities are endowed with additional income and less likely to be food insecure. Consistent with the hypothesis, participation in off-farm activities is positively and significantly associated with farm households' food security status (at probability level of 10%), all else equal. This finding is in tandem with Babatunde *et al.* (2007) that espoused that engagement in off-farm activity brings in money thereby corroborating the food security situation of the household.

#### **4.30 Constraints to household food security**

The constraints to household food security from the perspectives of head of households are presented in Table 4.24. The results from the table revealed the most widely reported constraint to household food security status among the farming households in the study area in order of importance. To avoid recall biases, respondents were asked to rank, in order of severity or importance, the factors that most affect their food security situation, 1 meaning the most important and 5 the least important. Erratic rainfall pattern or high susceptibility to drought was the most



cited constraint to household food security among respondents in the study area. Understandably, since most of the farmers rely on rains for their farming activities, their major concern is always the rains cannot be predicted. Again, most of the household heads also complain of lack of income generating alternatives availability in the study area and hence even when farming becomes unproductive, they still have nothing to hold on to. Most of the farmers complain that, even with the long period of the dry seasons, they hardly get other forms of income generating activities to participate in. Additionally, respondents said that, their lands are increasingly becoming infertile and as such the need for agricultural inputs like fertilizer and improved seeds is inevitably. However, these agricultural inputs are hardly available to farmers and thereby the production capacities of these farming households are reduced to unbearable limits. Access to credit also featured as a constraint to household food security. Many head of households complained that it is either difficult to get credit or that high interest rate are enough to scare them. Not surprisingly, government policies was said to also be factor that contribute to household food security. The respondents complain that government is not doing enough to assist farmers.



**Table 4. 24: Constraints to household food security in the study area**

Constraint to Food security	Mean Rank	Rank
Erratic Rainfall/susceptibility to drought	1.90	1
Lack of income generating alternatives	2.51	2
Lack of access to agricultural inputs	2.95	3
Lack to access to credit	3.68	4
Government policies	4.25	5

Source: Field survey, 2014

### 4.31 Conclusion

This study was set out to examine the influence of farming household participation in irrigation farming on household food security status. This chapter provides results from the study. Descriptive statistics, bivariate and multivariate analyses were used for the data analysis. Logistics regression was used to estimate the relationship between the main variable of interest and household food security. Consistent with extant evidence from the literature, households that participate in irrigation farming are significantly more likely to be food secure relative to households that do not participate in irrigation farming, all else equal.



## CHAPTER FIVE

### SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

#### 5.0 Introduction

This chapter explicitly provides a summary for the study as well as draw valuable conclusions based on the findings and objectives of the study. The results of the study also served as the conduit for the research policy implications to be enumerated.

#### 5.1 Summary

This thesis was set out to examine the relationship between households' heads participation in irrigation farming and household food security status in the catchment area of the Veia irrigation dam in the Bongo district of the Upper East Region of Ghana. The study employed the use of primary data set collected from four communities namely Veia, Bongo Nyariga, Gowrie, and Zaare. The data was collected in the months of April and May of the year 2014. Multistage sampling procedure was used for selection of households to be included for the analysis of the food security situation in the study area. In all 148 households were used for the final analysis even though 160 households responded to the survey. Some households (12 in number) were however dropped from the analysis simply because they either provided incomplete or inconsistent information. Weekly food consumption estimates were taken from these households to be used as the construction of the food security index.







To establish food security status of head of households in the study area, the study constructed Food Security Index and determined the food security status of each household based on the food security line using the Recommended Daily Calorie Required approach as used by Babatunde *et al.*, (2007) and kuwornu *et al.*, (2013). Households whose Daily Calorie Intake were equal or higher than Recommended Daily Calorie Required were considered food secure households and those whose Daily Calorie Intake were below the Recommended Daily Calorie Required were considered food insecure households. The results from the food security index showed that, majority (54.7%) of the head of households are food insecure and 45.3% of the head of households are food secure. Descriptive statistics also showed that 47% of the head of households were users of irrigation and 53% were non-users of irrigation. The study further revealed from the bivariate analysis that 65.2 % of food secure households were found to be users of irrigation whereas 27.8% were non-users. Parallel to this concerning food insecure household, 34.8% were users and 72.2% were non users. The use of logistics regression model in the multivariate analysis further confirmed the relationship between irrigation farming and household food security. Regression diagnostics and post estimation test was conducted to ensure that the parameter estimates are consistent, reliable and unbiased. Policy recommendations are then tabled based on the results of the study.

## 5.2 Conclusions

Household food security status has ignited considerable interest in recent times among development practitioners, researchers as well as policy makers in search of non-monetary/financial factors that are related to it because it constitute a major constraint to development to many developing nations. The soaring nature of household food insecurity and its attendant consequences among smallholder farming households has been able to generate the need for this research. Several interventions and alternative are available to vulnerable households to help mitigate food insecurity. Among these interventions include irrigation farming that is meant to cover for production inadequacies from the short and unpredictable rainy season. The Veia irrigation Dam serves a number of communities in its catchment area and even beyond. However, there are few empirical studies that have tried to estimate the impact of irrigation farming on household food security in Veia catchment area. This study filled the gap in the literature by estimating the impact of irrigation farming on household food security in the catchment area of the Veia irrigation dam. It is therefore evident from the study that, most farming households in the Catchment area of the Veia irrigation dam are food insecure. Also, non-users of irrigation are more food insecure relative to users of irrigation. Total food production level among users of irrigation is higher than non-users of irrigation. Most farming household heads' do not engage in any economic activity except farming.



Household access to credit services and extension services are very low within the study area and many of these head of households do not receive remittances.

Household heads' participation in irrigation has significant effect on improving household food security in the catchment area of Vea irrigation dam.

Household head's participation in irrigation farming, ownership of a donkey/cattle, access to credit and participation in non-farm activities are the significant determinants of household food security status in the study area.

The major constraints to household food security are erratic rainfall and lack of alternative income generating activities in the study area.

### **5.3 Recommendations**

Several policy issues emerged from the main findings of this study.

#### **1. Motivating farmers in the participation of irrigation farming**

Farmers within the catchment area of the irrigation dams should be encourage to patronize irrigation so as to boost the production capacities of farming households and hence help address food shortages. Stakeholders or Government through the municipal and district offices of MoFA should motivate irrigation farmers by providing them with agricultural inputs on subsidized prices and also, other free incentives. Sustainable food security interventions must therefore not exclude the improvement in the productivity of agricultural sector through use of irrigation.

#### **2. Improvement in the construction of irrigation schemes.**

The study indicated that household food insecurity is inherent among farming households that do not engage in irrigation farming and therefore, fighting household



food insecurity means combating the constraints to irrigation farming. To this, government and all other stakeholders that are involved in the development and management of irrigation schemes should make concerted efforts to develop/construct more irrigation dams so as enhance farming households' engagement in irrigation farming.

**3. Strategies and programs of government and other stakeholders targeting food security should put much priority on irrigation farming.**

Development strategies and programs targeting food security through agricultural production should therefore place priority on irrigation agriculture. Hence, the development of small scale irrigation activities should be further strengthened by the government and other stakeholders.

**4. Capacity building for the farmers by intensifying non- farming vocational training.**

As the study result disclosed that it is important to stress on non-farming activities to supplement the agriculture sector so as to develop sustainable livelihood systems in the study area. To this, government and civil societies need to organize alternative skills training programs like carpentry, soap making, dress making just to mention but few for farming households so that they can engage in non-farming activities during the dry season to supplement their earnings.

**5. Development strategies and programs targeting food security should put much priority on livestock farming.**

Donkey/cattle is the main draft power source for crop land preparation that directly contributes to betterment of food security status of the area. Donkeys use in farming



stabilizes the problem of excessive human productive labor and rainfall variability faced in the area. Therefore, it is imperative that development strategy should be able to give due attention for livestock sector in availing of donkey farming through credit and overall management of livestock production that aimed at improving food security status of people.

**6. Expansion and promotion of family planning programs or services.**

Since household size is negatively related to household food security status, it is recommended to government and other stakeholders in the health sector should intensify the promotion of family planning programs and educate farming households on the need to keep smaller family size.

**7. Provision of credit facilities in the form of cash or agricultural inputs and broadening the pro-poor policies of the country.**

Access to credit is also critical in ensuring household food security among farming households in the catchment area of Veia irrigation dam, therefore government through the municipal and district offices of MoFA should provide credit facilities in the form of cash or agricultural inputs to farmers in order to boost production. The government and other stakeholders should also extend the pro-poor policies such as the Livelihood Empowerment Against Poverty program (LEAP) and or Microfinance and Small Loans Center (MASLOC) to assist the farming household access credit to enhance their production efficiencies.



#### **5.4 Limitations of the study and directions for further research**

A basic limitation of studies of this kind normally relate to the use cross sectional data. Although the data was informative for estimating household food security status among farming households in the catchment area of Veia irrigation dam, the cross-sectional nature of the study principally provides a one-time measure of household food security in the study area and this cannot adequately provide a good measure of the association between food security and participation in irrigation farming. The food security situation among the households could be seasonal. Some households could be more food secure within the period of the study but food insecure in other months of the same year. Hence, the differences in months or seasons could be catered for. The use of longitudinal datasets would be preferable to scrutinize the actual causalities.

The scope of the study did not also include determining the particular period of the year when the farming households are worse off in terms of food insecurity. This could have provided valuable policy prescription as to which period of the year these household would need some social support from government, civil society and all other abled institution working towards ensuring the vulnerable in the society are protected. The sample size was also relatively small due to time and financial resources constraints. Future studies should include more households in order to ensure more validity in the results.



The scope, nature, and findings of the study therefore suggest that further research is imperative and therefore future research should place premium on unraveling the period (month) of the year where farming household are mostly food insecure.

Again, other specific research questions that emerged from this study relate to;

- 1) What motivates farmers to participate in irrigation farming?
- 2) What are households copying strategies to food insecurity?
- 3) How sustainable or desirable are the copying strategies of food insecure households?

Future studies should therefore explore these areas as they may reveal intriguing findings for policy prescriptions.



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**APPENDICES**

**APPENDIX A**

**GRADUATE SCHOOL**

**FACULTY OF INTEGRATED DEVELOPMENT STUDIES**

**DEPARTMENT OF AFRICAN AND GENERAL STUDIES**

**MPHIL DEVELOPMENT STUDIES**

**IRRIGATION AND HOUSEHOLD FOOD SECURITY AMONG FARMING**

**HOUSEHOLDS: EVIDENCE FROM VEA IRRIGATION IN THE BONGO**

**DISTRICT OF THE UPPER EAST REGION, GHANA**

**QUESTIONNAIRE FOR HOUSEHOLD SURVEY**

This questionnaire is designed to obtain data on issues pertaining to food security in the Upper East region specifically Ve, Bongo Nyariga, Gowrie, and Zaare. It is part of requirement towards the award of MPhil in Development Studies. All data provided will be treated as confidential and will be used solely for the purpose of the study.

Interviewer \_\_\_\_\_

Date of Interviewer \_\_\_\_\_/2014

Questionnaire Number \_\_\_\_\_

Community/Village \_\_\_\_\_

District \_\_\_\_\_



**SECTION A: HOUSEHOLD DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS**



Name of respondent	Gender (Code A)	Age (years)	Marital status (Code B)	Level of Education (Code C)
Household size (total number of people in the household) _____				
No. of people (less than 6 years): _____ Male _____ Female _____				
No. of people (6-18 years): _____ Male _____ Female _____				
No. of people (18+ years): _____ Male _____ Female _____				
<p><b><u>Code A</u></b>      <b><u>Code B</u></b>      <b><u>Code C</u></b></p> <p>0 = Female      1 = Single      0 = No Schooling      5 = Training</p> <p>College/polytechnic/Diploma</p>				

1 = Male	2 = Married	1 = Primary	6 = University				
(bachelor)							
	3 = Divorced	2 = MSLC/JHS	7 = University				
(Graduate or above)							
	4 = Separated	3 = SHS					
	5 = Widow(er)	4 = Technical/Vocational					
Years	spent	to	reach	his/her	level	of	education
<hr/>							

**(Responses to be provided by household head/primary decision maker)**

1. Number of years engaged in farming (up to 2013 season)

\_\_\_\_\_

2. Were you a member of any farmers' organization (**an organisation that exists to build capacity and enforce collective bargaining power**) in the 2013 crop year? 01 Yes [ ] 02 No [ ] (**If no move to Q6**)

3. If yes, give the name of the Farmer Based Organisation (FBO)

\_\_\_\_\_

4. If no, why

\_\_\_\_\_





5. Ethnicity 01 Guruni [ ] 02 Talansi [ ] 03 Kasem [ ] 04 Bulsi [ ] 05 Nankana [ ] 06 Others [ ] (specify) \_\_\_\_\_
6. Religion 01 Christian [ ] 02 Islam [ ] 03 Traditional [ ] 04 Other [ ] (specify) \_\_\_\_\_
7. Total amount of arable land available for farming in the 2013 season (in acres) \_\_\_\_\_
8. Amount of land cultivated to all crops in the 2013 season (in acres) \_\_\_\_\_
9. Do you own the land devoted to the crop cultivation? Yes [ ] No [ ]
10. If no, how did you pay for it? Cash [ ] portion of produce [ ] other [ ] (specify) \_\_\_\_\_
11. Did you request for and **receive** credit in the 2013 season? 01 Yes [ ] 02 No [ ]
12. If yes, what was the form of the credit? 01 Agricultural inputs [ ] 02 Cash [ ] 03 Both [ ] 04 Other (specify) \_\_\_\_\_
13. If agricultural input(s) (in reference to Q12), indicate the input(s) you received \_\_\_\_\_
14. If cash (in reference to Q12), indicate the amount received \_\_\_\_\_ and the source of it \_\_\_\_\_
15. If no, any reason? \_\_\_\_\_
16. Did you have contact with any extension officer in the 2013 season? 01 Yes [ ] 02 No [ ]
17. If yes, how many working visits did you have with the extension officer (s)? \_\_\_\_\_

18. Which type of services did you receive from the extension officer (s)?

01 Production service 02 [ ] 03 Credit service [ ] 04 Processing of agricultural produces [ ] 05 Trading [ ] 06 Other [ ] (specify)

\_\_\_\_\_

Non-farm income			
19. Did you engage in any non-farm activity in the 2013 season? 01 Yes [ ] 02 No [ ] (If no move to section C)			
20. If yes, what were the sources of your non-farm income? Indicate below.			
N o.	Tick	Non-farm income Activity	Amount in cash (GH¢)
1		Non-farm wage income e.g. security, teaching etc.	
2		Self-employed income: e.g. trading, artisan, carpentry, pito brewing etc.	
3		Others e.g. pension, capital earnings etc.	
Total Amount GH¢			
21. Did you receive remittance in the 2013 season? 01 Yes [ ] 02 No [ ]			
22. If yes, indicate the total amount you received			
_____			

**SECTION B: PRODUCTION, CONSUMPTION, MARKETING AND PURCHASING ISSUES**

Production		
A. Rainfed		
Crop	Quantity produced	Unit of measurement
B. Irrigation		



Crop	Quantity produced	Unit of measurement



1. For how long have you been in irrigation?.....
2. What type of irrigation method did you use? 0. Furrow 02. Flooding 03. Drip irrigation 04. Others specify.....
3. Why did you practice the method chosen above? 01. Slope of the land 02. Nature of the climate 03. Soil type 04. Use of water efficiently 05. Others specify.....
4. Was there enough irrigation water for farming? 01. Yes 02. No
5. If 'no' what did you think is the cause? 01. From the main source. 02. The pump capacity is low 03. Water conveyance system was not functioning 04 Water distribution management was poor 05. Others specify.....
6. Were you discriminated in the use of irrigation water? 01. Yes 02. No
7. If 'yes' what do you think is the cause? 01. Ethnic group 02. Gender 03. Position in politics 04. Your religion 05. Size of your land 06. Type of crop 07. Others specify.....
8. How was water distributed to irrigation farmers? 01. Based on the land size 02. Crop type 03. Commitments on payment of fees for water use 04. Others specify.....

9. What is the main purpose for using the Veia irrigation? 01. Generate income 02. Food provision 03. Provision of feed for livestock 04. Specify if others.....

10. How is the Veia irrigation important to you? 01. Very important 02. Not important 03. Normal

11. Has your life changed after using Veia irrigation? 01. Yes 02. No

12. If yes what is the indicator? 01. Paying your children school fees 02. Building a new house 03. Being able to produce a variety of food 04 Increase in income 05. Others specify.....

13. Did you produce enough yields for your household consumption from irrigation last year? 01. Yes 02. No

14. If 'no' could that be water related issue? 01. Yes 02. No

Sales, Purchases and Consumption					
Crop	Sales		Purchases		Consumption/week
	Quantity	Price/unit	Quantity	Price/unit	

**SECTION C: HOUSEHOLD ASSET ENDOWMENT**

**Livestock ownership**

1. Do you have livestock? 01 Yes 02. No



2. If yes indicate the number and the value of livestock in the table below

Type of Livestock	Pigs	Donkey	Cow	Chicken	Sheep	Goat	Ducks
Number							
Value (measured based on maturity)							

If others specify .....

**Ownership of Farming Implements 2012/2013**

1. Do you have any asset for farming? 01. Yes 02. No

2. If yes indicate the number and value at the time of purchase and currently in the table below.

Type of asset	Number of asset	Value of the Asset at the time of purchase	Value of the Asset currently
Plough			
Tractor			
Cultivator			
Hoe			
Knap-sack			
Sprayer			
Harrows			





Watering can			
Cutlass			
Shovels			
Seed planter			
Others.....			
1.			
2.			
3.			

**SECTION D : CONSTRAINTS TO HOUSEHOLD FOOD SECURITY**

**Rank challenges on a scale of 1 to 5. One is considered the most challenging constraint and five least challenging constraint.**

<b>Constraints</b>	<b>Rank</b>
Erratic rainfall pattern	
Lack of access to credit	
Lack of income generation activities and alternatives	
Lack of access to agricultural input	
Government policies	



**Appendix B**

**Table 1 Correlation Matrix**

Variables	FS	Irrig	Edu	HSize	Remit	NFA	Credit	Exten	Exp	Prod	D&C	Age
Food security	1											
Irrigation	0.53	1										
Education	0.34	0.17	1									
Household Size	-0.47	0.04	-0.34	1								
Remittances	0.45	0.02	0.27	0.28	1							
Non-farm act	0.66	0.32	0.11	0.46	0.08	1						
Credit	0.42	0.38	0.39	0.19	0.13	0.03	1					
Extension ser	0.33	0.29	0.51	0.29	0.01	0.32	0.14	1				
Farming exp	0.41	0.48	0.09	0.05	0.03	0.36	0.02	0.35	1			
Own prod	0.59	0.54	0.34	0.42	0.07	-0.26	0.01	0.03	0.52	1		
Donkey/Cattle	0.67	0.17	0.13	0.21	0.09	0.47	0.15	0.07	0.04	0.48	1	
Age	-0.52	0.22	-0.23	0.25	0.46	-0.37	-0.28	-0.31	0.56	-0.29	0.27	1

Source: Computed from Field survey, 2014

