AN ASSESSMENT OF THE IMPACT OF SMALL SCALE IRRIGATION SCHEMES ON LIVELIHOODS AND POVERTY REDUCTION IN THE UPPER EAST REGION

BY

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DECLARATION

I hereby declare that this submission is my own work towards the MSc. Development Policy and Planning and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

Economic growth and poverty reduction has been the main thrust of the Government of Ghana as enshrined in the Ghana Poverty Reduction Strategy and Growth and Poverty Reduction (GPRSI&II) and the GSGDA over the period of 2003 to 2013. In order to achieve these objectives agriculture which is a major sector that provides livelihood for over 80% of Ghanaians has being targeted and a number of policies and interventions proposed and initiated. Trends in development and climate variability have made it imperative for the transformation of the agricultural sector. Irrigation development has been one of the attempts towards modernizing the sector. The Ghana Irrigation Development Authority (GIDA) is established with the task of promoting, supporting and managing irrigation technology in Ghana. The Upper East region has 220 dams and dugouts as at 2007 and estimated at 300 by 2011 as targeted by the Ministry of Food and Agriculture (MOFA). The region is also endowed with a network of rivers and valleys that enhance the practice of irrigation. Communities have taken the acquisition of dams and dugouts and machines for pumping water as major community assets.

This research is a comparative study of communities with irrigation practice and communities without irrigation practice as well as households and farmers that engage in irrigation and those that do not to establish the cause and effects of the results of the investment in small scale irrigation practice on the livelihoods of smallholder farmers towards poverty reduction. The focus is on small scale irrigation that is practiced, controlled and managed by the farmers in their own way.

A comparative analysis of surrogate indicators of data collected on the dependent variables which are poverty reduction and livelihood development, the study revealed that irrigation has effect on the living conditions of smallholder farmers towards improving yields, expanding length of employment, reducing hunger gaps and at the meso level affects food prices, migration and community asset building including roads. But the effect would have been greater if the practice did not face challenges such as inadequate access to credit facility, extension service and irrigable lands. Less women than men carry out farming activities and attempts needs to be made to reduce the gap so that many men as women would engage in irrigation practice to help reduce poverty.

This research recommends further investment into the practice and investigations into identifying and controlling pest and disease of irrigated crops.

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DEDICATION

I dedicate this work to my children, Governor Awinpang Akudugu and Godson-Abraham Atiewyn Akudugu, Genevieve Winiman Akudugu and Husband, George Mbawin Akudugu.

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AusAID	Australian Agency for International Development
CAADP	Comprehensive Africa Agriculture Development Programme
CARE	Care and Relief Every Where
CIDA,	Canadian International development Agency
CSIR	Council for Scientific and Industrial Research
CWSA	Community Water and Sanitation Agency
DAs	District Assemblies
DANIDA	Danish International Development Agency
DFID	Department for International Development
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
FAO	Food and Agricultural Organisation
FASDEP	Food and Agricultural Sector Development Policy
GAMA	Greater Accra metropolitan Assembly
GDP	Gross Domestic Product
GIDA	Ghana Irrigation Development Authority
GLSS	Ghana Living Standards Survey
GPN	Global Policy Network
GPRS I	Ghana Poverty Reduction Strategy
GPRS II	Growth and Poverty Reduction strategy
GWCL	Ghana Water Company Limited
GSGDA	Ghana Shared Growth and Development Agenda
ICOUR	Irrigation Company of Upper east Region
IDS	Institute for International Development
IFAD	International fund for Agricultural Development
IPTRID	International Programme for Technology and Research in Irrigation and Drainage
IRDD	Irrigation, Reclamation, and Drainage Department
IWRM	Integrated Water Resources Management
MDGs	Millennium Development Goals

MEST	Ministry of Environment, Science and Technology
MOFA	Ministry of Food and Agriculture
MTDP	Medium Term Development plan
MWH	Ministry of Works and Housing
NEPAD	New Partnership for African Development
NZAID	New Zealand Agency for International Development
PSIA	Poverty and social impact analysis
SMC	Supreme Military Council
U.S	United States
UER	Upper East region
UN	United Nations
UNDP	United Nations Development Programmes
WARM	Water Resources Management
WAWI	West Africa Water Initiative
WCED	World Commission on Environment and Development
WEICO	Weija Irrigation Company
WRI	Water Research Institute
WWF	World Wide Fund for Nature

CHAPTER ONE
OVERVIEW OF THE STUDY

1.1 Background to the Study

Agriculture is a major contributor in rural poverty reduction and improvement in livelihood in Ghana. Majority of rural community members depend largely on small-scale farming as the major livelihood strategy and little or no alternative livelihood source. The Asuming Brempong et al (2005) has mentioned that about 3,225,910 representing 81% of farming population are small holder farmers whose survival depends on farming. Their major livelihood asset base for this strategy is land which is said to be small ranging from 4 hectares in the forest ecological zone to 1.2 ha in the interior savannah. The Upper East for instance has an average land holding size of 1.2 ha (Andah et al 2003). This small land holding size has implication on level of production and attempt needs to be done to increase productivity as area of cultivation is diminishing in quantity and quality. This calls for the need to improve on agricultural technology in rural Ghana.

As a result of the above, the development of irrigational facilities to support agricultural transformation and hence rural poverty reduction and improvement in livelihoods has seen the light of the day by government and relevant actors. In order to enhance the development of agriculture, attempts has been made through the development and implementation of policies which include The Ghana poverty reduction Strategy (GPRSI) and the Growth and Poverty Reduction Strategy (GPRSII), The Medium Term Agricultural Development Program (MTADP), the Accelerated Agricultural Growth and Development Strategy (AAGDS), and the Food and Agricultural Sector Development Policy (FASDEP I and II). All the mentioned documents have their focus as shifting or the transition from rural subsistent farming environment to mechanised commercially attractive, viable and dynamic sector. FASDEP is based on the realisation that Ghana cannot achieve its planned economic growth and poverty reduction without significant improvement on the performance of the agricultural sector (FASDEP, 2002).

Though the investment in the irrigation technology in Ghana has faced some challenges it cannot also be said that it went without affecting the lives of beneficiary communities, the local economy and national development as a whole. It is worth investigating to evaluate the contributions or otherwise adverse effects of the irrigation facilities among communities and smallholder farming households.

This study tried to investigate on how institutional and household investment in irrigation technology has affected livelihood development towards poverty reduction in relation to change in income levels, food security, employment generation, and asset building among rural communities in the Upper East using Bawku West District, Garu Tempane District and Bawku municipality as a case study. It also tried to establish linkages between irrigation development and poverty reduction and how other infrastructural development alongside irrigation infrastructure could promote agricultural development

1.2 Problem Statement

The agricultural sector has played a significant role and is expected to continue to play a major role in Ghana's economic growth and development in the short to medium term. It contributed the highest proportion to gross domestic product (GDP) since independence but has of recent being overtaking by the services sector which contributed up to 32.8% against 32.4% of agricultural GDP contribution in 2010 (MOFEP 2011). Agriculture offers job avenues to the highest proportion of the economically active population, about 50% of the total labour force, mainly as farmers, farm labourers, and other workers in agricultural related activities (GPRS II Annual Progress Report, 2008).

Ghana's recent agricultural performance has been quite impressive but raises questions of sustainability as its performance begins to see a downturn and losing its prominence to the service sector by 2010. In the period 2001 to 2006, it has grown by 5.5% annually, with a lot of this growth occurring in crops-both cocoa and other cash crops, including some new horticultural products such as fruits and vegetables. However, it is

not seen as sustainable for two reasons. First, the historical average rate of agricultural growth has been lower: 2% for 1991-95, and 3.9% for 1996-2000. Second, the recent growth spurt has been driven largely by extension of the land under cultivation through the block farming programme, inter alia, with little or no productivity growth. The scope for productivity growth is large: data on yield gaps between Ghanaian productivity levels for crops, compared to achievable yields, shows gaps in the range of 20% for oil palm, to 40% for maize and rice, to 60% for cocoa (ISSER 2009, 2010, MoFEP 2010, 2011). Aside these two reasons of the downward trend of the sector other factors such as over reliance on unstable weather conditions, low technology adoption rate, and frequent natural disasters such as drought, disease outbreak and floods adds to the reasons for the poor performance of the agricultural sector in Ghana.

The results of the above have been myriad and varied including low incomes for farm households, poor yield widening households hunger gaps, seasonal unemployment, poor access to basic services, and low asset base which leads to widening poverty levels among farmers especially small holders. Poverty is the inability to command sufficient resources to satisfy basic needs (Todaro 2003). This means the inability of people to meet basic needs such as food, health, education, shelter and to participate in decision making that affect them. Though the national poverty level figures shows a decline, the spatial disparity shows that the three Northern regions has majority of its members still wallowing in poverty with the Upper East having 88% of poverty by 2008.

To address the above issue several efforts have been made during the years past and now to address the situation. These efforts include the fertiliser subsidy, The Northern Rural Growth Project (NRGP), The Rice Sector Support Project (RSSP), the Food Security and Environmental Facility (FSEF) Project and the establishment of the Savannah Accelerated Development Authority (SADA), the Millennium Development Authority and the Bui Dam City Project among others. Each of these projects and institutions has put irrigation technology development as a tool to increase production and productivity especially in northern Ghana where the weather conditions are relatively unpredictable.

All these efforts are geared towards improving on the livelihoods of peasant farmers but have met a lot of challenges. Some of these challenges are the perennial flooding that has bridged over 80 dams in the Upper East alone since 2007, smuggling of subsidized fertiliser out of the country the recent being the Kia vehicle intercepted in the Garu Tempane district with over 200 bags of compound fertiliser attempting to cross to Togo in July 2011. Aside these challenges the rainfall patterns have changed with very late onset in recent times. For instance, this researcher observed for the purpose of the study that the rains began to set in for 2011 in mid June and farmers began vigorous sowing in July and experienced drought for almost three weeks with the rains bouncing back again in August and stopping in October. This event has automatically reduced the farming period for the season to 4 months if previous patterns remain unchanged. This situation makes the adoption of irrigation technology become part of community asset building and a practice to complement rain fed farming in many parts of the Upper East especially.

The fundamental issue here is whether the cry for irrigation as a technology for all year farming has an impact on poverty reduction and livelihood development among rural farmers in Ghana and especially within the Upper East region. It is therefore an attempt to find out whether efforts towards irrigation technology development is yielding fruits on poverty reduction and as well as providing alternative livelihoods towards reducing poverty within local and the national economic development context using Bawku west District, Garu Tempane district and Bawku Municipality within the Upper east region as a case study.

1.3 Research Questions

The study tried to answer the following questions;

1) What are the types and forms of irrigation schemes available in the study communities?
2) What are the types and levels of agricultural production in the studied communities and districts?

3) What has been the impact of irrigation technology on agricultural production and productivity?
4) How has irrigation technology affected livelihood conditions of farming households and communities?
5) In what ways can irrigation be promoted to support rural livelihood development?

1.4 Objectives of the Study

The broad objective of this study is to show the extent of benefits or non benefits derived from the use of small scale irrigation on poverty. The specific objectives for this study are to:

1) Identify and examine the types and forms of irrigation schemes available in the study communities and districts.
2) Assess the types and levels of agricultural production in the studied communities and districts.
3) Compare and contrast agricultural production performance between farmers practicing irrigation and farmers who do not within the communities and districts of the study.
4) Evaluate the effect of irrigation practice on livelihood conditions among farming households and communities
5) Propose recommendations on how to increase and improve on the practice of irrigation technology towards poverty alleviation and boost wealth creation.

1.5 Hypothesis

This study is based on the hypothesis that investment in irrigation technology has influence on rural agricultural livelihood development and poverty reduction. The study makes a preposition that an investment in any amount of irrigation technology by any stakeholder will cause an effect in the direction of livelihood development and poverty reduction. Due to the fact that it is difficult to measure livelihoods and poverty reduction on their own the study identifies other surrogate variables to these dependent variables for analysis and testing to determine whether this preposition should be rejected or accepted. The surrogate variables were tested using data collected on the

control and discrete such as household size, cropping area and size, hunger gaps, labour engagement, access to technology and market. Only two of the hypothesis on the variables that could be tested for decisions were selected and tested for generalised decisions on the major hypotheses.

The following hypothesis were tested during data analysis and discussions

1. H0: Irrigation farmers do not hire more labour than rain fed farmers.
   H1: Irrigation farmers hire more labour than rain fed farmers
2. H0: Rain fed farmers do not experience more hunger gaps than irrigation farmers.
   H1: Rain fed farmers experience more hunger gaps than irrigation farmers

1.6 Justification

In the face of high demands for irrigation facility as a modernisation tool in the light of erratic rainfall patterns that leads to low small holder agricultural production and productivity levels, research into the impact of investment in irrigation technology as an agricultural innovation is relevant. The results set the direction for decisions to stop or further invest in the innovation to boost agricultural development within Ghanaian communities.

Secondly, the research is relevant in the sense that it provides valid data to institutions and departments that invest in irrigation technology about the quantum of change imparted to small holder farmers towards poverty reduction, food security, and creation of alternative livelihoods towards local economic development. The significance of this study is to conduct a thorough investigation into the contribution that irrigation makes towards poverty reduction and improving living conditions among small farming families

The result of the study provides empirical evidence on the linkages between irrigation and poverty reduction for stakeholders interested in agricultural development for economic growth. The evidence provided serves as bases for advocating for the

expansion and development of irrigation within the Upper East region and the country as a whole

The study serves as an evaluation report for Governmental and Nongovernmental Organizations who have invested so far in the Region toward irrigation development. The outcome of the study serves as an input to policy makers and stakeholders concerned with developing semi arid areas of the savannah on strategies to promote and improve small scale irrigation farming to contribute to incomes, food security and employment sustainably.

1.7 The Scope of the Study

This study was carried out in the Upper East Region of Ghana. This region was chosen due to the fact that the Upper East presumably has a large concentration of irrigable lands that are being developed to enhance agricultural production in the country. This is because of its strategic location as part of the catchments drained by The White Volta River, Red Volta River, River Sissili and River Kulpawn (Akomeah et al., 2009). The Tono and Vea irrigation schemes alone cover areas of 2,490 and 850 ha respectively (Yilma *et al*., 2008). Due to limited funds and time the study limited itself to three districts within the Upper East Region but intensive review of the relevant secondary data was carried out for the whole region by visiting and collecting documented data from the Regional Ministry of Food and Agriculture Organisation (MoFA) and The Ghana Irrigation Development Authority (GIDA) in the Upper East Region.

The study concerned itself with the micro-level impacts which are realized at farm, household, and local levels, and these affect intermediate variables of poverty including cropping intensity, land and water productivity of crops, labour engagement, and household income. Small scale irrigation in this study was based on Turner (1994) definition as cited by Abeera (2004) as irrigation on small plots where farmers have majority of control, using technologies which they can effectively operate and maintain.

1.8 Limitations of the Studies

The study faced some challenges such as financial inadequacy to employ support, limited time to carryout longitudinal studies and analysis to identify longer term and multiplier effects of the technology as anticipated at the beginning of the study. The experience of farmers with some NGOs and research institutions on paying for time spent with them during data collection has made it difficult for students to access information free from them. This led to several calls that yielded increased cost on travelling.

1.9 Organization of the Report

The study is organized into five chapters. Chapter one gives an overview of the study describing the problem, the purpose of the study, what it needs to achieve and the scope of the work. Chapter two reviews the relevant literature from related studies such as the concept of poverty and livelihood, methodologies, approaches to irrigation technology delivery in Ghana, the linkage between irrigation, poverty reduction and livelihood development and concludes with a conceptual framework for the study. Chapter three examines the framework and the methods employed to address the objectives of the study. Data used, sources and methods of data collection are also described in chapter three. Chapter four presents the field data analysis and discussions of the study. Chapter five discusses the major findings of the study and gives recommendations for improving certain conditions to enhance or reduce the positive and negative effects of irrigation practice respectively.

CHAPTER TWO
A REVIEW OF AGRICULTURE LIVELIHOOD AND POVERTY REDUCTION INTER-RELATIONS

2.0 Introduction

This chapter takes a critical look at what other authors and theories have said in relation to the subject of the study. The content of this chapter reviews discussions on irrigation as an innovative farming tool, its types and approaches, livelihood patterns as related to irrigation practice and the linkage between irrigation practice and poverty reduction. The output of this review sets the conceptual framework for the study and finally set the basis for data collection approaches and procedures and data discussion and analysis in the preceding chapters.

2.1 Definition and Explanation of Relevant Terms and Concepts

2.1.1 Poverty as a Concept

According to the NDPC (2003) poverty is lack of basic necessities and services such as food, clothing and place to sleep and rest after the day's work. The NDPC stresses that it means an inability to send children to school; not being able to pay for medical care for the family when they are sick; or having no property. This is manifested through hunger, malnutrition, high morbidity and mortality rates, low life expectancy, increase in school dropout, low levels of education, and increase in crime. Personal conflicts and loss of integrity were also mentioned as both a characteristic and a manifestation of poverty. This definition of poverty by the NDPC is in consonance with recent international outlook on poverty (World Bank, 2000; IFAD, 2002; UNDP, 2000). These bodies view poverty in terms of income levels but in relative terms and a process rather than a state of being. The major thought of poverty in this study is viewed as having little or no access to food and income to support one's life demands (needs and wants) as well as lack of assets to cope with life endeavour and shocks. This is in conformity with the contention of Van Huis and Meerman (1997) that most farmers in sub-Saharan Africa have small holdings of less than two hectares in West Africa using traditional techniques to produce the bulk of the food.

Poverty is multi dimensional and has been recognised that a new way of thinking about poverty reduction is needed if the first Millennium Development Goal of reducing by one half the proportion of people living in poverty by 2015 is to be achieved. Poverty dimensions are wide and complex and vary between regions, countries, communities and individuals. Invariably, the basic requirement of a life free from poverty is access and entitlement to a variety of assets and livelihood strategies that can sustain households and individuals through the stresses and shocks of life.

2.1.2 Livelihood

Livelihood is a concept that defies any straight jacket definition. Whiles it can be viewed as assets and resources that can be assessed and used to make means to an end, others see it as having access and control to resources. This view is implicitly supported by Cahn (2003) in his argument that livelihood comprised the capabilities, assets (including both material and social resources) and activities required for a means of living: a livelihood is sustainable when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future (Carney, 1998:4). The emphasis on access and control is influenced by the cultural, political, social and economic settings of the society in which the individual is found. Ellis (2000) agrees with this assertion when in his definition of a 'livelihood' he has placed more emphasis on the access to assets and activities that is influenced by social relations (gender, class, kin, belief systems) and institutions.

The assets in the center of this study are irrigation facility and access to irrigable land, labour and service delivery by institutions and agencies. Things that people do to earn a living or revenue can be said to be livelihood strategies. Livelihood strategies are composed of activities that generate the means of household survival (Ellis, 2000). These strategies change as conditions of the environment change and culture also changes.

2.1.3 Agriculture Modernisation

This may be described in terms of the gradual but sustained transition from subsistence to specialized production. It is seen as a process of transforming traditional agriculture into a commercial one characterized by the commercial production, using technologies and [practices that maximize the productivity of land and at the same time trying to minimize danger to the value of natural assets and to the health of human. In agricultural modernization attempts are made to use high valued inputs including seed breeds and agrochemicals, mechanization, irrigation, record keeping, business orientation, improved marketing and buoyant service delivery system Asumining-Boamping et al (2005).

2.1.4 Smallholder Farmers

In its direct description, "smallholder farmer" is the connotation of a farmer with limited land availability. Whiles other connotations may outline a broader view of it as "resource-poor" farmers: e.g. those with limited capital (including animals), fragmented holdings, and limited access to inputs. They are risk prone and vulnerable in different conditions. They mostly have relatively small farm sizes and are unable to satisfy their commitment. They are seen as farmers with land and labour as their major asset which yields very low productivity. They sometimes do sharecropping and unable to feed their families all year round. Ghana's Poverty and Social Impact Analysis (PSIA: Asuming-Brempong et al. 2004) perfectly makes a similar case for Ghanaian farmers, arguing that different resource and risk conditions better define smallholders than simple measures of landholdings.

Chamberlin (2007) and The Ministry of Food Agriculture (MOFA 2006) maintains it that "Agriculture is predominantly on a smallholder basis in Ghana. About 90% of farm holdings are less than 2 hectares in size," although sources for these numbers are also un-cited. Asuming-Brempong et al. (2004) using wealth rankings (although with somewhat ambiguous methods), the PSIA defines five categories of Ghanaian smallholders: *Large Scale Commercial Farmers*, *Small Commercial Farmers*, *Semi-Commercial Farmers*, *Non-Poor Complex Diverse Risk Prone Farmers*, and *Poor*

Complex Diverse Risk Prone Farmers. The latter three categories are together said to constitute smallholder farmers. The report generates some indicators of prevalence of smallholders on the basis of "the assumption that [non-commercial smallholders] constitute about 95% of the agricultural population" although this assumption is undefended.

Other characteristics for defining smallholder farmer include subsistence which is a largely low market orientation; other important defining characteristics include conceptualizing smallholders as resource poor farmers (i.e. including such considerations as land quality and access to technologies such as irrigation) and farm enterprises primarily dependent upon family labor.

Throughout this study the term smallholder farmer is mostly meant for subsistent farmers with small and fragmented land holding that may still use traditional production methods. Smallholder farmers are more vulnerable to the vagaries of weather and market failures.

2.1.5 Vulnerability

Devereux, (2001) says vulnerability is a concept which combines exposure to a threat with the susceptibility or sensitivity to its adverse consequences. In Chambers (1998) vulnerability refers to exposure to contingencies and stress and difficulty in coping with them. Thus vulnerability has both external side and the internal side. External side because it is associated to risk, shocks and stress which the individual has limited control and an internal side due to the fact that the individual must be able to defend and more strengthened to cope with the damaging loss but where he is defenceless and lack the means to cope with the damage and loss then vulnerability sets in. According to Asumining- Boamping et al (2005) vulnerability is closely linked to assets ownership and they tried to explain further that the source of resistance are assets and entitlements that individuals, households and communities moblise and manage during hardships. The more assets of an individual, household or a community the higher their level of resistance to shock and threats but the greater your level of asset erosion the greater

your level of insecurity. Smallholder farmers by their nature are vulnerable and need transforming strategies to be able to build resistance to their vulnerability. These transforming strategies must support smallholder livelihood development which includes agricultural modernization that involves irrigation because of the role of water in agriculture.

2.1.6 Risk

Risk can be said to be the likelihood of occurrence of condition of loss or the degree of probability of loss. It is seen as the likelihood of occurrence of an exogegenous adverse effect or potentially non exogenous event such ad disability and old age, funerals, and others linked to life circles (Farrington, Slater and Holmes, 2004; Siegel and Alwang, 1999). Arguing in relation to Devereux (2001) risk and uncertainty can result in loss of welfare. Risk is analyzed based on the exposure and susceptibility to vulnerability conditions. Risk and the susceptibility of the smallholder farmer come from different sources which include:

Production risk; that is the likelihood of potential loss from production due to floods, droughts pests and diseases, shifts in season and loss of soil fertility among others.

Credit risk; is the probability of default in servicing loans by smallholder farmers , untimely access to loans, inappropriate interest rates limited access to loans from formal institutions.

Income risk; income fluctuations according to Asumining- Boampong et al (2005) are associated with year to year output and price fluctuations. Among others, the situation results from the predominance of rain fed agriculture and the impact of climate variability. Trade and marketing risk is due to disruption of export and imports from one location to another due to conflicts, poor roads infrastructure, market locations and lack of storage facility at market places.

Labour risk; farm labour abundance or scarcity at the peak or off seasons. Incidence of disease can also bring decline in the productivity of labour especially during rainy season where malaria incidence is high and that is also the critical farming season.

2.2 Poverty Dynamics in Ghana

The Poverty and Social Impact Assessment by Asuming- Brempong et al (2005) indicated that in the 1990s Ghana experienced a deepening poverty, which is evident in the intensification of vulnerability and exclusion among certain groups and areas. The document further states that the rate of decrease in poverty levels was lagging far behind the rate of population growth in the country. It mentioned that out of the 10 regions in the country 5 had more than 40% of their population living in poverty as at 1999. Among these 5 regions, the three Northern regions (Upper East, Upper West and Northern regions) were the most affected regions in the country. Nine out of 10 people in the Upper East region, 8 out of 10 in the Upper West regions, 7 out of 10 in Northern region and five out of ten in the central regions were classified as poor in 1999 (GSS 2000).

The NDPC (2005) argues that on the basis of north-south spatial disparity, the situation is much better in the north southern part than in the northern sector. It said for example, that the severity of the health situation in northern Ghana is about two to three times that prevailing in Greater Accra region. This was attributed to issues like low rates of child immunization and high prevalence of diseases in the northern part of the country. Diarrhea for instance is 31% prevalent in the north as against 18% in the south. The level of malnutrition among children under five years shows that children in the north are more prone to malnutrition with 34-38% than those in the south who had 25-27% and 26% for the national average (GOG, 2003).

On the part of education as a sector, there is a problem of less adequate infrastructure where some basic schools in Ghana still sit under trees for lessons and this is more severe in the rural areas. There is also a high incidence of school dropout at about 20% for boys and 30% for girls at the primary level, At the JHS level the dropout rate is 15%

for boys and 30% for girls. Northern Ghana is most prevalent with the cases of low enrolment, gender disparities and alarmingly low quality of education (GOG, 2003-2005). In general the poor have low levels of education, or conversely, poverty incidence is highest among the uneducated (NDPC 2005).

2.3 The Livelihoods of Smallholder Farmers in Ghana

Households and community livelihood development is build upon the fact that they have adequate capacity to recognize and use resources effectively to make end means whiles overcoming shocks. DFID distinguishes five categories of assets (or capital) – natural, social, human, physical and financial (Carney, 1998) in Cahn (2003).

The types of assets that contribute to the livelihoods of farmers especially small holders as identified by Carney (1999) are:

1. Natural assets; natural resources which include land, water, wildlife, biodiversity, environmental resources;
2. Physical assets: production equipment (which include hoe, plough), basic infrastructure e.g. shelter, roads, water, energy, communications)
3. Financial assets: savings, credit, remittances, pensions
4. Human assets: skills, health, availability of labour
5. Social assets: Networks, membership of groups, relationship of trust, access to wider institutions of society

An individual employ these assets to sustain a present livelihood, but with a desire to attain a better livelihood or welfare represented by the livelihood outcomes; more income, increases wellbeing, reduced vulnerability, improved food security and sustainable use of natural resources. In order to reach his or her objective of improved standard of living individuals employ livelihood strategies that combine the assets available to him or her. These strategies are either facilitated or constrained by policies, institutions and processes on one hand and by the external environment (or vulnerability factors such as drought, sickness, conflict etc) on the other hand (PSIA, 2005).

Agriculture is the means of livelihood of almost two-thirds of the work force in rural Ghana. In the face of vicissitudes of all kinds, farmers follow time tested as well as innovative methods of growing maize, rice, cocoa, yam, cassava, plantain, groundnuts, tomatoes, melon, cabbage and other fruit crops and many other crops in order to accomplish the challenging task of feeding themselves and the nation.

Such activities vary from ecological zone to another depending on the available assets. These are farming activities and off-farm activities. For instance the major farming activities for the Sudan savannah ecological zone in Ghana include rainy season crop production e.g. millet, maize, bambara beans, groundnuts, rice, and cowpea; dry season crops using irrigation e.g. tomatoes, pepper, onion, leafy vegetables, rice; livestock production e.g. cattle, goats, guinea fowls, and pigs which is both a dry season and rainy season venture. Off-farm livelihood activities in this zone include petty trading, pito brewing, firewood collection, artisan works like mason, weaving and pottery (PSIA, 2005)

2.3.1 Livelihood Assets of the Small Holder Farmers

Gender is an integral and inseparable part of rural livelihoods. Men and women have different assets, access and control to resources and opportunities. Women rarely own land, may have lower skills capacity due to discriminatory access to education as children, and their access to productive resources as well as decision making tend to occur through the mediation of men (Rao 2006). Women typically confront a narrower range of labour markets especially agro based than men and lower wage rates. In the Upper East Region women before this 20th century era were not permitted to keep livestock and sell livestock but to have a hidden face in livestock production where she keeps the livestock outside her matrimonial home with an affine or a acquaintance. Some crops were feminized such as legumes, pulses, and vegetables, men were to cultivate the cereals and tubers. The land tenure system never favoured women because land is seen as an ancestral possession that belonged to the family for peasant cultivation using family labour. Because women do not own land and bullocks they have to depend entirely on men for land and animal traction. This makes the women to

start late in production and find it difficult to compete favourably with men in term of production. Women dominate in agro-processing and marketing of the farm produce and post harvest handling of the cultivated crops.

Currently women have access to land and other productive resources but having entitlement and control to such resources is still invisible. Irrigation infrastructure has become an important asset to agricultural production for both crops and livestock. Where there are rivers and lakes, forest and good road network agricultural production becomes enhanced.

2.3.2 The Livelihood Strategies of Smallholder Farmer in Ghana

Things that people do to earn a living or revenue can be said to be livelihood strategies. Livelihood strategies are composed of activities that generate the means of household survival (Ellis, 2000). These strategies change as conditions of the environment change and culture also change.

Scoones (1998) in Cahn (2003) identifies three types of rural livelihood strategies: agricultural intensification or extensification, livelihood diversification including both paid employment and rural enterprises, and migration (including income generation and remittances). Agriculture is the major source of livelihood for rural communities and has the potential of influencing the other sources of livelihood development if efficiently developed. The characteristic of the smallholder as described earlier in this chapter identifies them to be poor, risk prone and more vulnerable to several circumstances. Their livelihood strategies are usually diverse and often complex. The idea of diverse livelihoods looks at some of the many ways people survive under severe poverty. They are basically coping strategies to their vulnerability and conditions under poverty. (Rao 2006)

Coping strategies under conditions of poverty include:

1. Home gardening (both rural and urban) and the exploitation of the microenvironments

2. Common property resources (CPR)-fishing, mining, fuel wood harvesting and selling, charcoal burning, quarry, mining by water points,
3. Transporting goods by horse and donkeys, and head portage
4. Migration for seasonal work
5. Seasonal food for work
6. Child labour
7. Agro processing e.g. pito brewing. milling, malting
8. Livestock rearing
9. Dry season farming

2.3.3 Transforming Institutions and Processes in the Smallholder Sector

Laws, policies, and societal norms are *structures* or organisations, and the *processes* and incentives that influence livelihood development. Access, control and use of assets to create a strategy for livelihood are influenced by these institutional structures and processes. An understanding of structures and processes provides the link between the micro (individual, household and community) and the macro (regional, government, powerful private enterprise) (Scoones, 1998, Carney, 1998, Ellis, 2000) as cited by Cahn (2003). Such an understanding helps to identify areas where restrictions, barriers or constraints occur and explain social process that could impact on livelihood sustainability (Scoones, 1998).

In Ghana the important institutions that support agricultural development and transformation are the Ministry of Food and Agriculture, with its various departments like Extension Services and Veterinary services, the Ghana Irrigation Development Authority (GIDA), and NGOs into food security and research institutions especially the various arms of the Center for Scientific and Industrial Research (CSIR). These institutions are tasked with responsibilities of promoting technological development and adoption, increased and efficient use of irrigation technology, access to researched information on crops and livestock. Among these institutions MoFA especially the veterinary and the extension service is the most decentralized institutions that reach out to the farmers. GIDA is basically at the regional level CSIR are in selected regions and

NGOs cannot be over relied on in terms of coverage. At the regional level, MOFA is represented by the Directorates and at the District the District agricultural development Units (DADU). Though it has a structure that seems good but in term of human resource it is limited by capacity. For instance the whole of Bawku West and Garu Tempane Districts have only one veterinary officers each and one AEA to handles more than one operational areas. Means of transport for extension delivery is poor as for instance in the Bawku west and the Garu Tempane including Bawku municipals Agricultural Extension Agents (AEAs) that do not have frequent access to fuel and motor bike maintenance allowances. Irrigation technology is catching up with farmers as coping strategy to rain fed farming challenges but GIDA is only at the regional level with a few engineers. Though the Committee called Research and Extension Linkage (RELC) is to facilitate the linkage between research institutions and the farmers they are for now not very efficient due to other reasons including limited finance. In terms of processes there had been several attempts and policies and programmes established to support the transformation of agriculture in Ghana. The FASDEP II and I, the GPRSII and I, the Medium Term Agricultural Development (MTADP), the Accelerated Agricultural Growth and Development strategy, The Northern Rural Growth Project (NRGP), The Savannah Accelerated Development Programme are institutions and processes that aims currently at transforming agricultural sector to boost productivity and production and reduce poverty levels in individuals and locations.

2.4 Agricultural Transformation through Irrigation Farming

Aziabah (2008) citing Stern (1979) defines irrigation as any process other than natural precipitation which supplies water to crops, orchards, grass or any other cultivated plants. This he says includes runoff, farming humid culture and micro and manual irrigation because they are important and significant features of small scale development. An irrigation system is an arrangement by which water is conveyed from a source to an area needing water to facilitate the production of desired crops. Such a system involves one or more sources of water; fields; a functioning set of principles and techniques adopted by humans to create a water flow pattern within the physical structure and the varying needs of the fields. An irrigation system requires institutional

arrangement for the construction and maintenance of physical facilities and procedures for the movement and distribution of water.

At the global level according to Siebert et al 2006 in Amosah (2009), 2,788,000 km^2 (689 million acres) of agricultural land was equipped with irrigation infrastructure around the 2000. About 68% of the area equipped for irrigation is located in Asia, 17% in America, 9% in Europe, 5% in Africa and 1% in Oceania. The largest continuous areas of high irrigation density are found in North India and Pakistan along the rivers Ganges and Indus, in the Hai He, Huang He and Yangtze basins in China, along the Nile River in Egypt and Sudan, in Missipipi-Missouri River basin and parts of Califonia.

2.4.1 Sizes of Irrigation Scheme

The Food and Agriculture Organisation has classified irrigation schemes into three categories in Sub-sahara Africa as large scale, (over 500 hectares), medium (50-500 hectares) and small (under 50 hectares). Aside this classification by the FAO there are different criteria for the classification of irrigation schemes in the world. The main criteria frequently used for the classification of irrigation schemes are irrigated areas, scale of operations and management types. The most commonly used is the small, medium and large as also used by the FAO in the above and its interpretation vary from one geographical location to another. For instance whiles in Ghana a 300 hectare scheme could be regarded as small scale but in India 10,000 ha is categorised as small scale (Asefa 2008:21 citing Smith 1998). Asefa 2008 referring to Rahmato 1990 mentioned that in Ethiopia during the Dergue regime, irrigation schemes were classified based on their sizes as 200ha for small size, 200-3000 ha as medium and above 3000ha as large.

2.4.2 Irrigation Methods

There are three methods of irrigation according to Freken (2005) based on the mode of water application. These are sprinkler irrigation, drip and surface irrigation.

Sprinkler irrigation: in this method of irrigation the field is distributed with water from pipes through over headed high pressure sprinklers or guns. These sprinklers are mounted overhead on permanently installed risers and supported by rotors driven by a ball drive, gear drive or impact mechanism. They could also be mounted on a moving platform connected to the water source with a hose.

Drip Irrigation: this form of irrigation which minimizes the use of water and fertilizer by directing water to the roots of plants and either by soil surface or valves, pipes and tubing and emitters to the roots. This is arguably said to be the innovation in agriculture which is seen to minimize water wastage and increase crop water utilization.

Surface Irrigation: This also referred to as flooding is a group of water application techniques where water is applied and distributed over the soil surface by gravity. In this mode of water application to crops the water is uncontrolled and therefore inherently inefficient.

2.4.3 Small Scale Irrigation Farming

Small scale irrigation that is projects below 100 ha which are the focus of this study involve individual or small groups of farms organized and managed by farmers usually independent of government resources (FAO, 1992). Turner (1994) defines small scale irrigation in Aberra (2004) as irrigation on small plots where farmers have the majority control, using technologies which they can effectively operate and maintain. Rahmato (1999:6) cited in Amosah 2009 defined small scale irrigation schemes as schemes that are controlled and managed by the users themselves. This type of irrigation has proved successful where large primary government controlled projects have failed. As Tefesse, (2003) reports that government managed (large and small-scale) schemes have generally performed far below expectations and most of the time, initial capital costs have not been recouped and the financial returns have not been able to cover operations and maintenance costs. Small scale irrigation is preferred because of the easy adaptability of the systems to local environmental and socioeconomic conditions. But more importantly, small scale irrigation has become important because of the recent shift in the development paradigm to 'development from below', an approach subsumed under 'sustainable development' (Adams 1990 in Aberra 2004 and Aziabah 2008).

Furthermore, smallholder schemes are attractive because of the low capital investment required and the demonstrated capacity of the beneficiaries to manage, operate and maintain the systems (Tefesse 2003 in Aziabah 2008).

Small scale irrigation can be highly productive in terms of yield per hectare of land. The energy input into large scale schemes can be up to fifteen times greater than that required in small scale schemes to produce the same output of crops (FAO, 1992). This is not to say that small scale irrigation is without challenges and difficulties. Some of these include: low levels of efficiency, lack of finance, inadequate marketing, and weak extension services among others.

2.4.4 Irrigation Development in Ghana

Poor rainfall distribution and its erratic nature in Ghana make the achievement of all-year cropping difficult. Supplementary irrigation therefore reduces the risks of crop failure. Furthermore, irrigation in the dry months between October and April allow all-year round cropping and increases productivity. 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. 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 is practiced 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 practiced in at least part of the currently irrigated area for more than 30 years.

2.5 Effects of Irrigation on Poverty Indicators

2.5.1 Influence of irrigation on agricultural production output

According to Lipton et al (2003) the first direct impact is on output levels. From a study of the impact of irrigation in Asia, Lipton and others came out that irrigation boosts total farm output and hence, with unchanged prices, raises farm incomes. It was found by that study that increased output levels may arise for any of at least three reasons. Firstly, irrigation improves yields through reduced crop loss due to erratic, unreliable or insufficient rainwater supply. Secondly, irrigation allows for the possibility of multiple-cropping, and so an increase in annual output. Thirdly, irrigation allows a greater area of land to be used for crops in areas where rain fed production is impossible or marginal. According to (Smith 2004) evidence for these effects is widespread, well documented and uncontroversial. For example, the FAO suggests that irrigation can increase yields for most crops by 100 to 400%, and that higher, less risky and more continuous levels of rural employment and income result from the higher cropping intensities, yields and more intensive and higher value crops and cultivation techniques of irrigated compared to rain-fed agriculture FAO, (1996) in Smith (2004). Hussain and Hanjra (2004), when trying to come out with the influence of irrigation on farmers output, mentioned that irrigation enables the poor and smallholders to achieve higher yields and that the productivity of crops grown under irrigated conditions is often substantially higher than that of the same crops under non irrigated/rain fed conditions.

Higher productivity helps to increase returns to farmers' endowments of land and labor resource. According to Hussain and Hanjra, 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.

2.5.2 Influence of irrigation on Income

First and most directly, where conditions are favourable irrigation can raise the incomes of those farmers with access to irrigated land. Lipton and Litchfield (2003) found out that income in irrigated areas had risen across India, though not uniformly. Citing Dhawan (1988) Lipton reiterated that the Indus basin average income rises from about

Rs 350 to about Rs 1 830 (1970-71 prices); in the Gangetic basin from Rs 440 to Rs 2 200; in the southern peninsula from Rs 530 to Rs 2 225; and from Rs 260 to Rs 4 550 in the Deccan plateau. Water control in agriculture may boost productivity and incomes by ensuring adequate water throughout the growing season, contributing to higher yields and quality (higher farm-gate prices) by eliminating water deficits and providing at least a measure of drought protection; securing a crop where rainfall is inadequate or too variable. This is so because of the availability of water for supplementary precipitation. This also allows a second or even a third crop by making water available in the dry season; as well as providing a cheaper or more secure supply of fodder for livestock (although irrigation may also involve some trade-offs with livestock production.)

2.5.3 Effect of irrigation on Employment

Lipton and Litchfield (2003) trying to elaborate on the influence of irrigation on employment relied on Binswanger and Quizon (1986) use of a general equilibrium model of India's agricultural post-Green Revolution sector to consider the effect of expanding irrigated area by 10 percent on the rural poor. The effect is to increase aggregate output by 2.7 percent and decrease the aggregate price level by 5.8 percent. Since irrigation requires labour, labour employment and real wages rise slightly. But this labour demand effect on irrigation is not very strong due to the inelastic final demand, which curtails output. Residual farm profits therefore decline by 4.8 percent due to higher labour costs and lower output prices associated with domestic absorption. Incomes of the landless are predicted to rise modestly from this (2.9 percent), whilst large farmers lose (-0.7 percent). All urban households gain substantially with the poorest showing the largest gain (6 percent).

2.5.4 Effect on Food Prices

Irrigation has the potential of influencing poverty via food prices. If irrigation leads to increases in staples or non-staple food output then this may result in lower prices for staples and food in imperfectly open economies or if there are significant transport costs internationally or from food surplus areas to towns or food deficit areas. Rural net purchasers of food will therefore gain from cheaper food, as will urban consumers. The

share of food expenditure on staples and the share of expenditure on food tend to fall as expenditure rises, and the majority of the rural poor are net food purchasers, receiving large proportions of their income from off-farm employment activities. Hence the fall in the staple price is likely to be poverty reducing. However low-income and possibly poor, small-farmers in areas not affected by extra irrigation – non irrigated or already-irrigated areas – may be net producers so harmed by falling prices and may even become poor, unless the increase in output offsets the price fall. Waged agricultural labourers, in addition to increased employment, will benefit from lower prices. Wage labourers will find their wage buys more food hence will benefit from falling prices, apart from employment changes.

2.5.5 Effect of Irrigation on Employment

The second direct effect on poverty is via employment. There are two sources of additional demand for labour created by irrigation projects. Irrigation projects firstly require labour for construction and on-going maintenance of canals, wells and pumps etc. This is likely to be an important sector of employment for the poor, especially the landless rural poor or rural households with excess labour or seasonal excess labour. Secondly, increased farm output as a result of irrigation will stimulate demand for farm labour both within the main cropping season and across new cropping seasons, increasing both numbers of workers required and length of employment period. Rural poverty levels may therefore be reduced by increased employment opportunities. In addition there may be effects that extend to other areas if irrigation projects reduce migration to urban areas, and so reduce the pool of job-seekers and relieve the downward pressure on urban wages and the upward pressure on prices of housing and other urban infrastructure (Lipton 2003).

2.5.6 Stabilization and Risk Reduction

By making employment and incomes more reliable (as well as higher) irrigation protects farmers from loss of assets and also prevents peasants from getting into debt-traps. In a bad monsoon, while rain fed crops may fail crops irrigated using groundwater usually yield well. Even if the groundwater table falls, it can recover during a more

humid period. Thus, irrigation acts as a buffer against bad years and hence the deprivation and indebtedness that these years may entail. Risk of disposing of assets such as mortgaging or selling land to buy food or meet debts, are reduced. Lipton and Litchfield also citing Howes (1985: 114) describe how irrigation by poor families with hand pumps has prevented them from becoming landless. Irrigation also liberates people from maintaining demeaning social relations such as with money-lenders. Chambers et al. (1989:18) in Lipton (2003) state that "for resource poor farmers and landless labourers alike, it ceases to be so necessary to 'touch the shoes of the rich' as insurance against those dreaded bad seasons or bad times of a year when food runs out and loans are needed to survive. Irrigation thus supports self-respecting independence".

2.5.7 Access to Credit

Swamikannu and Berger (2009) in trying to find the impact of credit on farm households tested credit on them. The results of their study showed that access to credit would enable households to change their land use from subsistence rain fed farming to high value crop irrigation farming. Even with 25% of interest rate, the study suggests that households apply for farm credit and expand their area under irrigation farming. The results show that access to credit would likely increase the average household income and food energy consumption. The application of mineral fertilizer (in kg per ha) could also triple with the access to credit which would help to improve the sustainability of agricultural land use in the region. The impacts of credit on welfare of the different farm types analyzed by their study revealed that access to credit could increase the income of the irrigation farm households (small dam and big dam farms) by 56% and 82 % respectively over the baseline income level, while the income of the rainfed farm households would increase only by 22 %. The results indicate that farm households who have physical access to irrigation land would be benefiting more by availing credit than subsistence rainfed farmers. From the above empirical findings by Swamikannu and Berger it can be said that, that providing access to credit without expansion of irrigation facilities would not give the intended result of improving the livelihood of poor subsistence rain fed farmers.

2.6 Risks to Poverty from Irrigation

Irrigation as an agricultural innovation to increase production and productivity can as well be a necessary evil such that it may not deliver proportionally greater benefits to the relatively 'rich' even when it improves the absolute position of the poor deterioration in relative poverty). Even sometimes irrigation may harm the poor and actually worsen absolute poverty. Evaluations of irrigation and the Green Revolution suggest that the first of these is most common but that the second is possible (Hasnip *et al*., 2001). Equity issues arise between geographical areas, and inter or intra households. Technological change will inevitably be better suited to some regions than to others, and hence the first of these dimensions of inequity is generally unavoidable. Irrigation's employment and linkage effects may benefit surrounding and wider areas, but inequities will tend to widen. If it occurs, depression of output prices for significant numbers of poor rain-fed net food producers is a concern. Rain-fed agricultural growth is also poverty reducing and should not be neglected. Productivity-raising technologies have equitable on-farm benefits when: they are scale-neutral and can be profitably adopted on farms of all sizes; land is equitably distributed with secure ownership or tenancy rights; efficient input, credit and product markets exist, giving all farms access to information, inputs and prevailing prices; and policies do not discriminate against small farmers and landless labourers (for example mechanization subsidies or anti small-scale biases in research and extension (Thirtle *et al*., 2001)). These conditions are rarely met by irrigation and it will usually reduce equity between households. Larger and relatively 'resource-rich' irrigators will benefit most, even if the poor usually still benefit in absolute terms. Equity impacts of projects vary also with time, in terms of both nature and number of beneficiaries as well as extent of the benefits.

Irrigation may worsen absolute poverty for some if it reinforces processes of land consolidation in which poor households lose rights to land, or if it is associated with displacement of labour by mechanization or herbicide use. Poor people may be displaced by the construction of reservoirs and canals, or their livelihoods may be adversely affected by upstream or downstream impacts. Badly designed or managed irrigation can negatively impact public health and human capital through the spread of

water-borne diseases, usually with a greater incidence for the poor. The consumption linkages that are major drivers of poverty reduction are likely to be less effective when income and land distribution are highly skewed. This is because the consumption patterns of the 'wealthy' may be oriented to imports and capital-intensive goods and services, rather than the offerings of rural non-farm suppliers. Barriers to entry in non-farm employment and micro-enterprise can arise from ethnicity or caste, gender, skill and education levels, access to information, mobility, transaction costs and risks.

2.7 Conceptual Framework: Inter-Relations between Agricultural Livelihood development and Poverty Reduction

The conceptual frame work acts like a map that gives coherence to empirical inquiry (Shields and Tajali 2006:313). A conceptual framework is used to outline possible courses of action or to present a preferred approach to an idea or thought. Conceptual frameworks are a type of intermediate theory that has the potential to connect all aspects of inquiry (e.g. problem definition, purpose, literature review methodology.)

The conceptual framework for analyzing and assessing the effects of small scale irrigation schemes on livelihoods and poverty reduction within the Upper East region is depicted in figure 2.1 below. The diagram assumes that agriculture and natural resources are very keen for economic development of each country. However recent climate change conditions have affected the use and development of such resources. This has widened the level of vulnerability for farmers especially small holder farmers to be able to cope with livelihood strategies towards achieving enhanced living condition. These vulnerability contexts for the farmer include; erratic rainfall patterns, droughts, floods, poor soils, pest and disease and low technology use.

Amidst these conditions rural communities can boast of available assets to support their livelihood. The types of assets that contribute to the livelihoods of farmers especially small holders as identified by Carney (1999) are five. Agriculture is the major source of livelihood for rural communities and has the potential of influencing the other sources of livelihood development if efficiently developed. The framework sees agricultural

intensification through adoption of irrigation technology, use of improved varieties and access to inputs as strategies towards achieving livelihoods objectives among small holder farmers.

The diagram assumes that MoFA, GIDA and NGOs and other institutions and structures if they support to enhance access to extension service, increase area under irrigation and implement policies meant to transform agriculture through irrigation farming, this will intend influence the access, use and control of the said assets. Then agricultural intensification through irrigation as a livelihood strategy would be enhanced to promote the achievement of the desired outcomes through this transformation.

The figure 2.1 in its simplest form is a livelihood framework that shows that an individual in a pentagon that represents the five assets (some add a sixth capital i.e. political asset). The individual employs these assets to sustain a present livelihood, but with a desire to attain a better livelihood or welfare represented by the livelihood outcomes; more income, increases wellbeing, reduced vulnerability, improved food security and sustainable use of natural resources. In order to reach his or her objective of improved standard of living the individual employs livelihood strategies that combine the assets available to him or her. These strategies are either facilitated or constrained by policies, institutions and processes on one hand and by the external environment (or vulnerability factors such as drought, sickness, conflict etc.) on the other hand (PSIA, 2005).

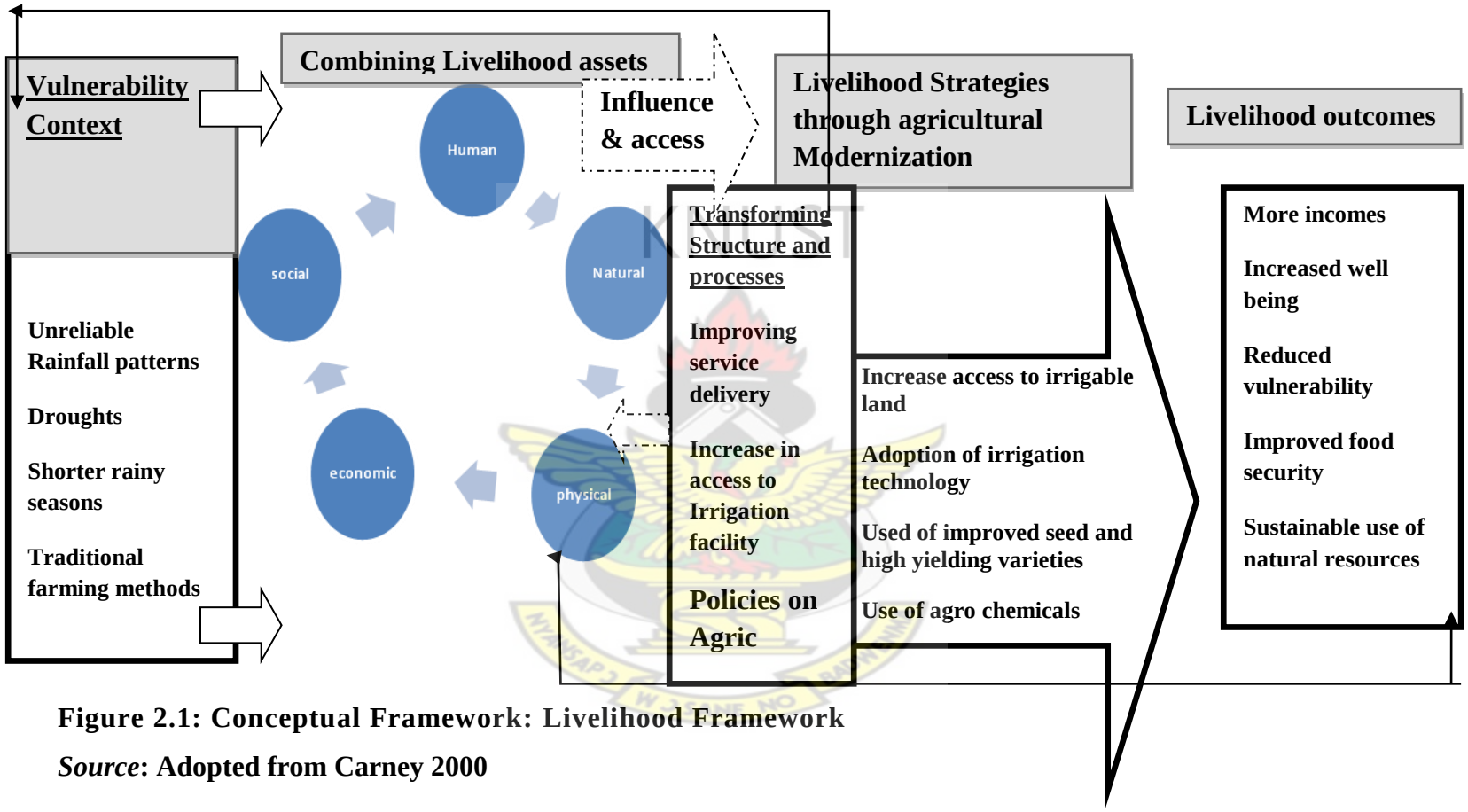

Figure 2.1: Conceptual Framework: Livelihood Framework

***Source*: Adopted from Carney 2000**

In the framework livelihood objectives are enhanced by the prevailing structures and policies that determine level of access ad control of resources towards achieving desired outcomes. For instance the Water Users Association controls the use and access to irrigation facilities and their constitution could limit women and other vulnerable groups access to the use of such facilities. For instance, in Binduri it was found out that women will have access to only half the portion of land men can access. That is to say if a man must be given a 10m square of irrigable land at the sight, then, a woman can only have 5m square. And also that most men of the community must have access to the irrigable land and so you have fewer women being part of the irrigation scheme. The tradition also demanded that the women support their husbands before working on theirs. These customs, tradition and policies will either promote the development and use of such assets as indicated in the framework or work against its achievement. The development of livelihood strategies to achieve the desired outcomes is also dependent on the level of transformation and modernisation of the relevant systems and processes. For instance, use of labour intensive methods of irrigation will limit production levels that can affect level of achieving livelihood objectives.

The achievement of livelihood goals and objectives implies reduction in poverty incidence where living conditions will have improved. Investment in irrigation technology is a way of improving the asset base of communities and the application and use of such facilities are livelihood strategies towards achieving poverty reduction goals through the support of relevant structures, institutions and policies.

CHAPTER THREE
METHODOLOGY AND APPROACH TO THE STUDY

3.1 Introduction

This chapter discusses the process and techniques employed for the research. These include the discussions on the research design; the population that was studied and how the sampled population was selected. To collect information for analyses data were collected and this chapter also gives description of how the data were collected and analysed using the computer software like the SPSS for data analysis.

3.2 Research Design

A research design as described by Ngworgu (1991) is a plan or blue print which specifies how data relating to a given problem should be collected and analysed. It provides the procedural outline for the conduct of any investigation. The design here is the experimental design; this is because it is seen to be the valid design which can be used to identify confidently the cause of any given effect in this study.

In general, if a research question involves determining the "effects" or "influences" of one variable (independent) on another (dependent), use of an experimental design is implied. The word experimental research has a range of definitions. In its broad sense definition of experimental research, is research where the scientist actively influences something to observe the consequences (Ross and Morrison 1992). In this case investment in small scale irrigation by relevant stakeholders is the influences and change in livelihood patterns, strategies and activities are the observable consequences studied. According to Bailey, (1987) an experiment definitely is one of the best methods in social science for establishing causal links. He further argues that it enables the investigator to measure the value of the dependent variables, introduce the independent variables he or she suspects to be the cause and observe whether any change ensues in the dependent variable.

This study applied both experimental design and case study. Experimental in the sense that it compared treatment groups in this case farmers, households and communities that practice irrigation technology with those farmers who do not. This is commonly called with and without comparison. The before and after comparison is also possible in this case but due to challenges in the time for the study it was rarely used. Due to the fact that the effects of the use of small scale irrigation schemes and non use effects were compared in this study implied control experimental which involves comparisons between appropriate treatment conditions. In this study the control group is referred to as the "farmers without irrigation infrastructure and technology" and the treatment group referred to as "farmers with the irrigation infrastructure and technology. The [treatment] here is the use and application of irrigation infrastructure and technology. Under the current study, investment in small scale irrigation is the independent variable and whereas livelihoods, agricultural transformation and poverty reduction are the dependent variables. Because the dependent variables mentioned here are difficult to measure, the study has therefore identified indicators or surrogate variables to help measure the impacts of the independent variable on the dependent ones.

Though the major design of the study is the experimental design, other descriptive approach was combined in the study. For instance a survey was carried out when trying to examine the impact of the technology on the individual treatment and control groups. Also case study became relevant when some households were visited to hear their stories on how irrigation had impacted on their livelihood and living conditions. These designs had become important because it combined to provide a systematic way of looking at events, collecting data and reporting them (Kumekpor 2002) among the control and treatment groups. This is because individuals of each group of the study population were studied separately using questionnaires and interviews to ascertain impacts.

3.3 Variables/Indicators Analyzed

Concepts that can take on more than one value or category along a continuum are variables. A variable such as area under irrigation, which has values or categories like

number, size, quality, distance, is a variable. Usually the values or categories of a variable are designated quantitatively (that is signified by numbers as in the case of 1, 2, 3 irrigation areas) but can also be designated by word labels (small or large, far or near, good or bad irrigation areas).

The relations between variables could be seen to be either positive or negative; the strength of their relationship that is symmetrical or asymmetrical (dependent and independent only in asymmetrical), linear or nonlinear; spurious or intervening. Only two of these relationships among variables are considered in this investigation thus asymmetrical relations and the negative or positive relations.

Due to the fact that the dependent variables which are livelihoods, poverty and agricultural transformation are difficult to measure, the surrogate variables that the study collected data on and analysed to verify the level of influence of small scale irrigation on the dependent variables are: output levels of farmers, access to credit and repayment, productivity per unit area, rate of expansion of farms, food security, employment rate. The independent variable that showed some level of altering in the dependent variables mentioned in this study is the use of small scale irrigation technology.

3.4 Unit of Analysis

The unit of analysis is the major entity that is being analyzed in a study. Kumekpor (2002:54) defined unit of analysis as the actual empirical units, object, occurrences etc. which must be measured in order to study a particular phenomenon. Unit of analysis can be categorised into three, namely; the individual, groups and social artefacts (Marlow, 2000). In this study two types of units of analysis are used; the individual and groups.

Individual in this study is composed of the individual farmers specifically the small holder farmer who carryout farming activities and also of those in the catchment area of

irrigated lands and facilities and use water from any source for cultivation. Some of them belong to the water users association of formal irrigation schemes.

Groups considered here as unit of analysis include households, water users associations and communities and organisations. Group is also used to refer to the individual farmers in groups, households and communities that practice or do not practice irrigation technology.

Basically the subjects in this study are farmers who are adopters **(with irrigation)** or non adopters **(without irrigation)** to irrigation technology. To further solicit information to validate what the farmers would be saying, institutions, organisations and individuals who support agricultural activities in the region were involved in the study. At the institutional level the units considered for data collection and analysis are Ghana Irrigation Development Authority (GIDA), Metro, Municipal and District Assemblies (MMDA), District Agricultural Development Units of MOFA, Non-governmental Organisations (NGO) in the area, Community Based Organisations (CBO) and Farmer Based Organisation (FBO). At the community level the subjects for the study were farming households, farmers, local extension agents, land owners and farm labourers.

The selection of household was based on their age and length of involvement in production through irrigation. This procedure was used for both control and treatment communities.

3.5 Sampling Techniques and Sampling Size

3.5.1 Sampling Design

Samples are very often drawn from a population to make estimates of population parameters from the corresponding sample statistics. The selection of a sample size is necessary since total enumerations of the study population are influenced by factors such as limited time and finance. The core principle is that the sample size should have

features which reflect the entire population, such that conclusions can be generalized for the entire population.

The districts to be studied were sampled from seven out of nine districts because the study was interested in small scale irrigation schemes, the districts where large scale irrigation schemes were found were not to be considered for the study. For this reason the Bongo district and the Kasena Nakana East districts were not part of the sample.

The total smallholder farmer population in the region according to regional MoFA Monitoring and Evaluation Unit (2011) fluctuates between 315,000 and 345,000 from 2005 to 2010. Out of this the estimated number of farmers who carry out small scale irrigation farming was 11,448(8,450men, 2,998females). The region has nine districts from which all the different sample frames for the study falls. Three districts were selected for the study based on the fact that they were closer to the researcher, and had high concentration of small scale irrigation practice

3.5.2 Sampling of Farmers and Communities

Determining the Sampling Size

The formula: $n = \frac{s^2}{SE^2}$ where n is the sample size, s standard deviation, and SE Standard Error **and** $n = \frac{N}{1} + N\ \alpha^2$ where; n = sample size, N = sample population or sample frame, α = confidence interval (which was 10% or 0.1), are used to determine the population sample size for a study. The sample size for this study was based on other factors which are time and other resource availability including money, and means of transport. Due to the limited time for the study and inadequate resource availability to cover the whole region a total of 30 communities were sampled within the 3 chosen Districts.

Convenience sampling procedure was employed in sampling both farmers and officers in organisations. In convenience sampling, the units are not covered by any randomness

or law of chance. What is important in this method is that, each unit satisfies the characteristics of the phenomenon; namely farmer practicing irrigation within a community that practiced irrigation or a farmer in a community that does not practice irrigation and the farmer as well does not practice irrigation and is available and ready to give time to engage in an interview or group discussions. Ten farmers were selected from each community that was sampled for the study.

This technique became necessary for adoption for this level of sampling because of time constraint which did not allow for call back visits on farmers who were not available on call. In addition some farmers were not ready to guarantee audience due to past experience with researchers that that took up to one to two hours of their time on interviews or questionnaires and never paid them for the use of their time instead of their economic activities.

Cluster sampling procedure: Due to lack of data on the location and demarcation of the communities within the selected districts and the non organized structure of the communities, cluster sampling was employed to put selected districts into clusters and from there used the convenience sampling technique to select farmers and households for studying. To identify treatment and control communities, institutions and relevant stakeholders were contacted to obtain a list for such communities for considerations.

Table 3.1 shows the districts selected and communities for both treatment and control groups.

Table 3.1: Selected Districts and Communities for the Study

Bawku West	**Garu Tempane**	**Bawku Municipality**
Settlements With irrigation Practice		
Sakom	Yabrago	Binduri
Wiiga	Kogire	Aniisi
Yarigu	Nwadug	Mandago
Timonde	Bugri	Bazua
Tonde	Gagbiri	Nafkoliga
Settlements Without irrigation practice		
Lamboya	Boko	Zawse
Kansogo	Duudankpikparig	Widaana
Googo	Songure	Deega
Yikurugu	Kparinboaka	Kpikarugu
Ankpaliga	Nate	Tambaalug

Source: Author's construct 2011

In order to select communities for the study in the three districts chosen, a list of communities practicing irrigation and those with the absence of irrigation practice were developed in collaboration with MOFA staff and key informants. Each district selected for the study was then put to five clusters each where two communities that is one with irrigation practice and one without irrigation were randomly selected from the list of communities with and without irrigation. In all 2 communities were selected in each cluster giving a total of 10 communities (5 with, 5 without) in each district. Tables 3.2 and 3.3 gives summary of the sampling process and the sample size used generally.

Table 3.2: Sampling size for Each District

	Name of Cluster					*Total*
Name of cluster	1	2	3	4	5	5
No. of sampled communities	2	2	2	2	2	10
Number of sampled irrigated communities	1	1	1	1	1	5
No. of sampled communities without irrigation	1	1	1	1	1	5
Sampled respondents with irrigation	10	10	10	10	10	50
Sampled respondents without irrigation	10	10	10	10	10	50
Total respondents			100			

Source: author's construct 2011

On the whole three districts were selected out of seven potential districts for the study and within each of the three districts five communities were selected as control communities and another five as treatment communities. A total of 30 communities were studied from the three selected districts being 10 from each district and in terms of farmers' population studied a total of 300 were studied out of the estimated 315,000 small holder farmers in the region, 100 in each district. Ten respondents were sampled from each community within a cluster making a total of 50 respondents adopting irrigation practice in small scale and 50 being farmers who do not practice irrigation for each district. Table 3.3 gives details of the sampling structure and size and outcome within the region.

Table 3.3: Activities leading to selection of samples within the Region

Activity	Out put	Total
Identification of Districts without large scale irrigation	7	7
Selection of Districts	3	3
Selection of irrigated communities per District	5	15
Selection of communities without irrigation per district	5	15
Selection of communities per District	10	30
Selection of farmers per community/district	10	100
Selection of farmers irrigated per community per district	10	50
Selection of farmers without irrigation	10	50
Total sampled farmers with irrigation	150	150
Total sampled farmers without irrigation	150	150
Total number of farmers sampled	300	300

3.6 Data collection Techniques

There are two major sources where data can be acquired in social research (Miller, 1991). These are the primary and secondary data sources. This study used data from both sources by employing various methods and techniques which include observation, focus group discussions, and use of key informants, interviews and case studies. Table 3.4 gives a summary of the data collected, methods used and sources they were obtained.

Table 3.4: Categories of data collected and sources

No.	Data Need	Data Source	Method of collection
1	Farm income,	Community and household members, Traders in irrigated crops and agricultural products	Observation, interview, questionnaire and focus group discussions
2	Farm employment,	Farm families, key informants, Traders in farm produce	Questionnaire, interview, discussions, observation
3	Farm investment,	Farm Families	Questionnaire, interview, discussions
4	Farm savings,	Farm families	Farm families, financial institutions
5	Household assets	Farm families	Observation, interviews and questionnaire
6	Hunger gaps,	Farm families	Interview, questionnaire
7	Access to Use of agricultural Technologies	Farm Families, Agricultural development Units Extension agents, FBOs, Farmers	Observation, discussions, interviews
8	Levels of production and type of production	Farm Families, Agricultural Development Units (MOFA)	Interviews, Questionnaire, focus group discussions
9	Yields of production	Farm families, Regional Agricultural Development Unit (RADU)/District Agricultural Development Unit (DADU)	Questionnaire, interviews
10	Farming population and communities	Key Informants, NGOs, MOFA	Questionnaire, Focus group discussions
11	Types and method of irrigation	GIDA, Farm families	Observation, interviews and questionnaire

Secondary data

Secondary data for the study was obtained through collecting relevant literature from text books, journals, newspapers and student research works and organisational reports in the subject being studied. Some data were also obtained from the electronic media. Information from these sources was useful for reviewing relevant literature and for validating findings.

Data were also collected from institutions such as GIDA, District Agricultural Development Unit (DADU) and Irrigation Company of the Upper East Region (ICOUR). Information regarding districts and the irrigable areas, communities practicing irrigation, yield of irrigated and non irrigated farms and regional profile were obtained from these institutions.

Primary data

Interviewing

It is an alternate method of collecting survey data where the researcher asks the questions orally and record respondents' answers (Babbie, 2007). In using the structured interview the study made use of a questionnaire to elicit information from individual farmers and households or groups. A total of 300 farmers were interviewed from both control and treatment groups. This method was preferred among the other techniques because it could reach to the relatively large number of respondents.

Focus group discussions were also employed to elicit information from a selected group of farmers with membership of at least five (5) using the unstructured interview approach. This approach enabled the respondents to freely express their opinion. This therefore, supports Yin's (1993) view that a good interview is one in which the interviewee takes over the control of the interview situation and speak freely. This approach was therefore intended to allow respondents to speak freely on how irrigation practices affect the development of their **livelihood**. It afforded the interviewee the opportunity to clarify any issues that were not understood and therefore made the responses more relevant and accurate (Babbie, 2007; Kreuger and Neuman, 2006).

Moreover, the researcher was able through this method to observe things to understand the context within which the answers were given.

Observation

Kuma (1999) defined observation as a purposeful, systematic and selective way of watching and listening to an interaction or phenomenon as it takes place without asking the respondent. He further outlined the basic conditions under which it is most appropriate to observe as: learning about interactions, functions and behaviours in a group. Observation as a method of collecting data is very relevant in research. It allows the researcher to study phenomena directly and allows the researcher to collect information that are not so much influenced by factors affecting both the researcher and the objects of the research.This is more so, relevant in situations where accurate information cannot be elicited by questioning.

3.6.1 Stages of Data Collection

The study has been conducted in three stages: the reconnaissance survey, main survey and in-depth survey. In these phases, data were collected on the irrigation practice as an innovation to crop production and the effect on micro, meso and macro levels from farmers and institutions supporting irrigation development.

The study started with the reconnaissance survey. This phase involved the selection of communities where the main survey was conducted. Communities were visited to familiarise, establish linkages and rapport, and build relationships with the relevant persons and institutions. Relevant institutions like MOFA, as well as GIDA and farmer groups in the various districts were also identified and contacted. Community irrigation sites such as dams, dugouts, rivers, valleys and other water points were visited to get acquainted and observe on-farm activities. The districts were clustered into five clusters based on MOFA zoning concepts. Markets were visited to observe the marketing of farm produce. Surveyors moved with AEAs around to get familiar with the communities in the district to facilitate the identification of communities with irrigation and communities without irrigation. Key informants were identified during this stage to

support in getting irrigated farmers in communities it is in this phase that secondary information was sourced and reviewed. This then led to the main survey phase.

In the main survey phase, the focus was to collect data on how irrigation has influenced households and communities' livelihood development and the impact on poverty in terms of access and control of inputs, asset building and employment, yields and hunger gaps. Households were randomly selected with convenience and interviewed using questionnaire. Staff members of relevant institutions like PAS Garu, MOFA, and GIDA also completed the questionnaire.

In depth interviews were carried out for selected groups and individuals. The groups included community leaders, experts and farmer group leaders in both irrigated and non irrigated communities, marketers of agricultural products.

The last phase, the validation study was to deepen understanding of specific issues that came up in the previous two phases. In this study, supplementary information was collected through the use of case studies and discussions. Follow up visits were made especially to MOFA, PAS Garu and GIDA.

3.7 Data Analysis

3.7.1 Data Analysis Techniques

For the purpose of this study, the "with and without" comparisons was used to study beneficiaries (direct and indirect) of irrigation schemes and non beneficiaries to identify the causes and levels of improvement or non improvement in variables such as income, production, productivity, employment, labour use, investment, savings, and food security.

(1) "With" and "without" comparisons of intermediate poverty-reducing indicators/variables—cropping intensity, crop productivity, and labour engagement

(2) "With" and "without" comparisons of poverty-related indicators—employment, incomes, income inequality, and incidence of poverty;

These comparisons of variables are presented in tables using univariate presentations where only one variable is analysed using frequency tables and measure of central tendency such as the range, mean, mode and standard deviation. A second form of data presentation in comparing variables is the bivariate presentation where two variables are compared using column and row variables in a fourfold table. A third type of data presentation occurred where three or more variables are compared and presented in a three variable two by two table called trivariate tables. These forms of presentations are necessary for reporting experimental studies and computing statistical analysis of variance.

The quantitative data were analysed with the assistance of the statistical software-Statistical Package for Social Sciences (SPSS). The descriptive statistics (e.g. cross tabulation to compare relationships) were used to assess the relationship between variables, and also using comparison of two dependent sample tests, and the chi-square to test the hypotheses. The cost and benefits analysis and farm investment analysis were used also to assess the impact of investing in irrigation.

3.7.2 Test of Hypothesis

The research is either to accept or reject the preposition that irrigation practice has impact on poverty and livelihood development. Test of hypothesis is also to further establish scientifically the relationship between the independent and the dependent variables. That is to find out the level of change in the dependent variables when an amount of the causal variable is introduced. Statistics used to infer to assumptions and justification of a hypothesis are called inferential statistics. The general inference to be tested is that some phenomenon that is true for a sample is also true for the population from which it is sampled.

The data used for testing hypothesis on impact of irrigation was data on labour engagement and hunger gaps between households with irrigation and those without irrigation and under irrigated farms and rain fed farms. Averages of the farm size, yields, number of cropping times and number of crops among others under irrigations and from rain fed farms were collected and used to establish relationship and differences among variables in cross tabulations. It was found out that there are differences in these variables that are measured and accepts the hypothesis that investment in small scale irrigation has influence on livelihood development and poverty reduction.

Averages of the indicators being measured using comparison of two dependent samples were used to further test the hypothesis using t-test and x^2 test at 0.05 level of significance for each of the variables tested. The hypothesis were tested in chapter four where two surrogate variables of the dependent variables; hunger gaps and labour engagement were tested using the chi square and t-test.

CHAPTER FOUR
IMPACT OF SMALL SCALE IRRIGATION ON AGRICULTURAL DEVELOPMENT

4.1 Introduction

Having discussed what data was collected and how it was done in chapter three, this chapter proceeds to describe the study area shortly and provides analysis and discussion on the impact and influence of small scale irrigation technology on agricultural livelihood and poverty.

4.2 Contextual Profile of Study Region

4.2.1 Physical ad Demographic Characteristics

Location and Population

The Upper East region is located between latitudes 10º 15' and 11º 10' North and longitudes 0º and 1º 40' West. To the west, it borders the Upper West Region and on its southern side the Northern Region. To the north of Upper East Region lies Burkina Faso, whilst Togo is in the east. It has a gross area of 8842 km2 (IFAD, 1991). There are nine administrative districts namely Bolga, Bongo, Builsa, Kasena-Nankana East, Kasena Nankana West, Talensi Nabdam, Bawku West, Bawku East and Garu Tempani. According to the population and housing census of 2000 (GSS, 2005), the region has a population of 920,089, made up of 442,492 males and 477,597 females with a population growth rate of 3% per annum. The Upper East Region has a comparatively high population density of 104.1 persons per km2 compared to the national average of 79.3 persons per km2. The population of the Upper East Region is ethnically diverse with different languages (Amegashie citing Birner *et al.*, 2005). Bawku municipal has a population of 205,849 whiles Garu Tempane is 133,333 (54,091 males and 59,239 females) with the same growth rate of 1.1. (ISSER, 2001).

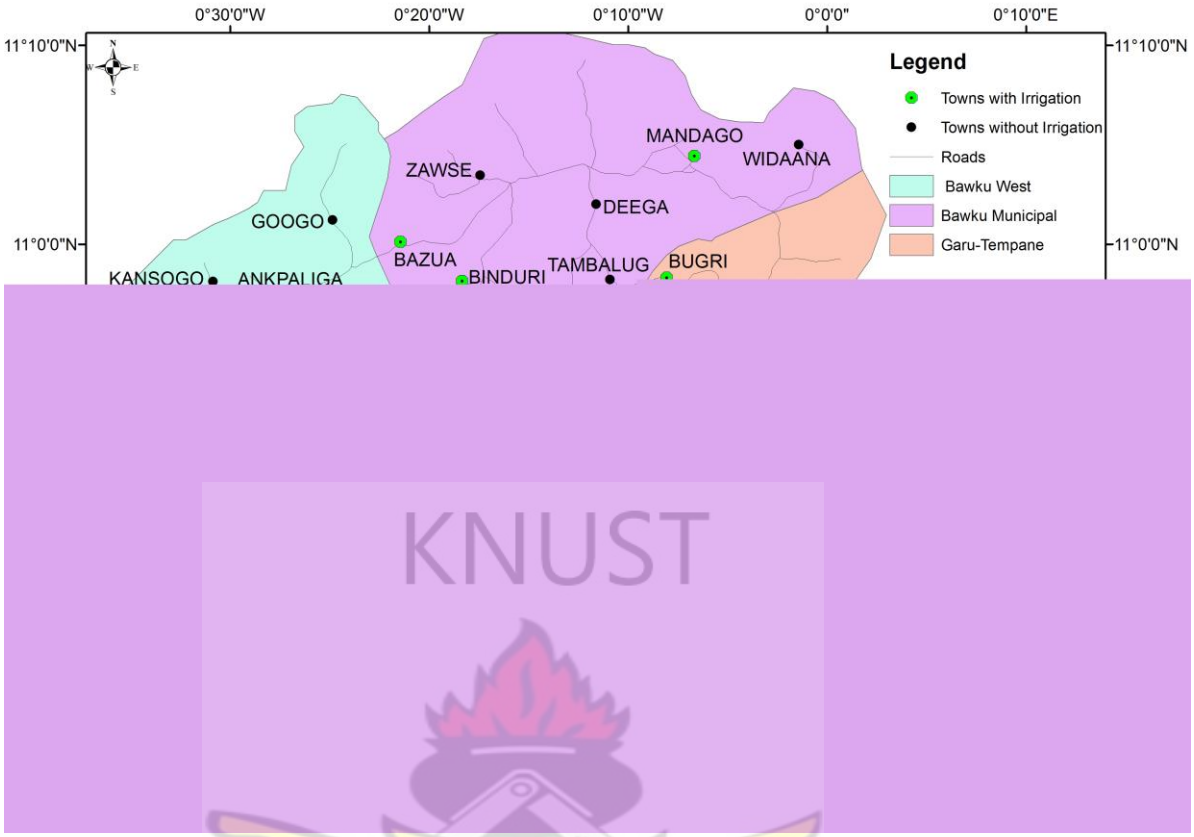

Figure 4.1: Map Showing the Upper East Region in Relation to Study Communities and Districts

Source: Field GIS Data, 2011

4.2.2 Climate Conditions of the Upper East Region

Amegashie 2009 in a study described the conditions of the upper east region to fall within the Inter-tropical Convergence Zone (ITCZ) whose climatic boundary oscillates annually between the south coast of Ghana and 20° north. As the boundary moves north and south it draws with it the associated weather zones. Rainfall in the region is uni-modal lasting from 5 - 6 months. It has a mean annual of 900 - 1000 mm and a dry period of 6 - 7months. Considerable variations exist between successive rainy seasons with respect to time of onset, duration and amount of rainfall received (Walker, 1962 in Amegashie 2009). The average temperature is 28.6°C, which is consistently high. Monthly averages range from 26.4°C at the peak of the rainy season in August to a maximum of 32.1°C in March – April at end of the dry season (Liebe, 2002). Average annual relative humidity is 55%. Relative humidity is highest during the rainy season

with values of 65% and may drop to a minimum value of less than 10% during the harmattan period in December and January. Relatively high temperatures and moderately low humidity in the dry season lead to high evapotranspiration (Liebe, 2002), thus contributing to the drying up of a lot of reservoirs in the region during the dry season.

4.2.3 Environmental conditions of the Upper East Region

The vegetation is Sudan savanna consisting of short drought and fire resistant deciduous trees interspersed with open savanna grassland. Grass is very sparse and in most areas the land is bare and severely eroded. Studies on the natural resources and livelihood systems in the region revealed that it is very difficult to find examples of natural vegetation due to the exploitation of the natural resource base for several hundred years (Needham, 1993 in Amegashie 2009). The natural vegetation has been modified by human activities, particularly agriculture which is almost entirely in the hands of smallholder farmers, who combine bush farm cultivation of distant fields with permanent cultivation of nearby compound farms. The region has the highest density of cattle, overgrazing being evident in some areas particularly near ponds and dams (Amegashie 2009 citing IFAD, 1991). Forest reserves also provide an abrupt change in tree population and type over significant areas. Common grasses include *Andropogon gayanus* in the less eroded areas and *Hyperrhenia spp*., *Aristida spp*. and *Heteropogon spp*. in the severely eroded areas. Common trees include *Anogeissus spp*., *Acacia spp*, *Triplochiton spp, Parkia biglobosa* (dawadawa) and *Vitelleria paradoxa* (shea butter).

4.2.4 Water Uses in the Upper East Region

The region has its main source of water from streams and rivers with little contribution from groundwater. Agricultural production uses most of the water for mainly irrigation and livestock production. Boreholes are the major sources of water supply for domestic purposes for the people of the UER although the yield of groundwater is generally low. The water used for agriculture and livestock production is mainly from reservoirs which are used to store water during the wet season. The water demand in the UER is expected to increase due to an anticipated increase in the population, urbanization and improved

standard of living of the people. Irrigation accounts for approximately 80 percent of the water use in the UER of Ghana and the entire Volta basin (Shiklomanov, 1999). Crops mostly grown in the area are maize, millet, rice and vegetables. Urban and rural water use is less at the moment. The rate of water use for domestic purpose is approximately 0.11 m3/s while that for irrigation purposes is 2m3/s. (Kwabena Wiafe, 1997).The type of irrigation mostly practiced in the UER is the gravity flow irrigation system with fewer technologies such as sprinkler and pump irrigation schemes.

The Water in the UER is a priceless commodity including the arid and semi-arid regions of the world where irregular rainfall is predominant. The Upper East is endowed with a lot of rivers, and water reservoirs both natural and man-made that promotes irrigation development in the region. The vegetation also supports livestock production and other craft work. The distribution of reservoirs seems to be equitably distributed spatially. Poverty incidence in the region as compared to others is second to the least in Ghana. The availability of such reservoirs enables water presence throughout the year for both irrigation and other agricultural purposes. In the UER of Ghana where there is a higher incidence of poverty as compared to the other regions, small scale irrigation schemes have become a source of livelihood development such as farming activities. Development of small reservoirs is an efficient way of developing small scale irrigation schemes within the region.

4.3 Background Features of Respondents

4.3.1 Age Distribution of Respondents

Out of the sample of 300, 33.3% which is one-third of the total sample size are within the ages of 33 to 38 with 20% being farmers who donot practice irrigation. Only four farmers representing 1.33% fall witin the ages of 21 to 26 and these are farmers who practice irrigation there is no farmer below within the ages of 21 and 26 who practice irrigation from the sample. The insignificant number within the age bracket of 21 to 26 might be attributed to the fact that it falls within the school going age of most youth. The 33.33% are from the age bracket that could be considered to be within the active working population in Ghana. From the figure 4.2 it could be said that majority of

farmers from the Upper East Region are within the ages of 27 to 50 representing 69.66%. This means that people who engage in farming are the actively employable populace who have the capacity to increase production.

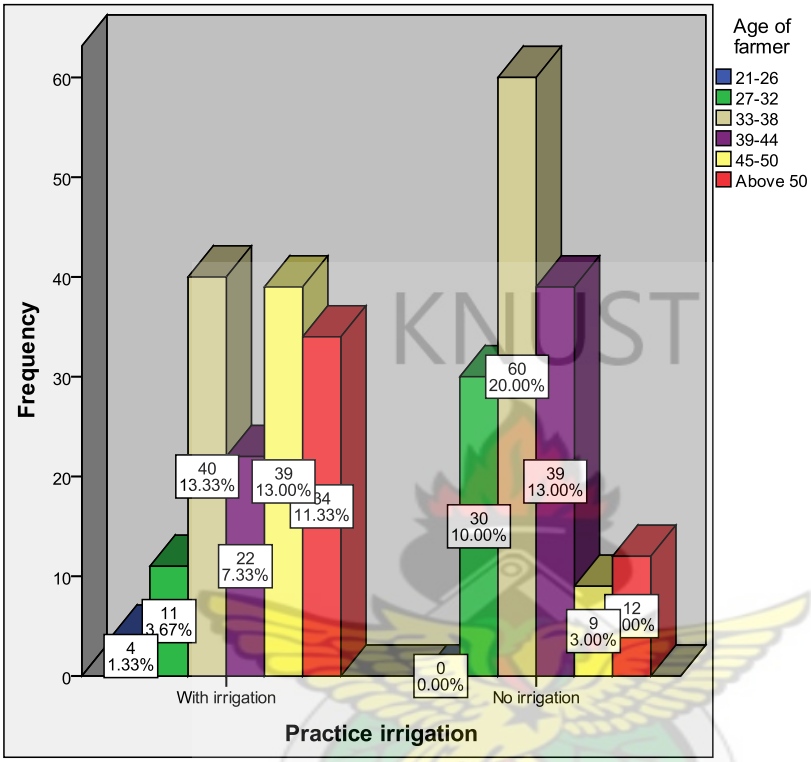

Figure 4.2: Age of Respondents

Source: Field survey, June 2011

4.3.2 Sex of Respondents

Figure 4.3 shows that out of the randomly selected respondents from the sampled population, 187 representing 62.33% are men and 37.67% being women. This suggests that farming is male dominated livelihood around the upper East region though some women have ventured into farming and this represents less than half whiles the population of farmers who are men is almost double that of women. The gender disaggregation of the figures is more revealing as it epitomizes the gender disparities that characterize the study area and the north in general (Karbo and Bruce, 2003; Atengdem and Dery, 1998). Out of the 37.6% women only 15.6% practice irrigation as

compared to 34% men. This disparity might be due to poor access to irrigable land by women.

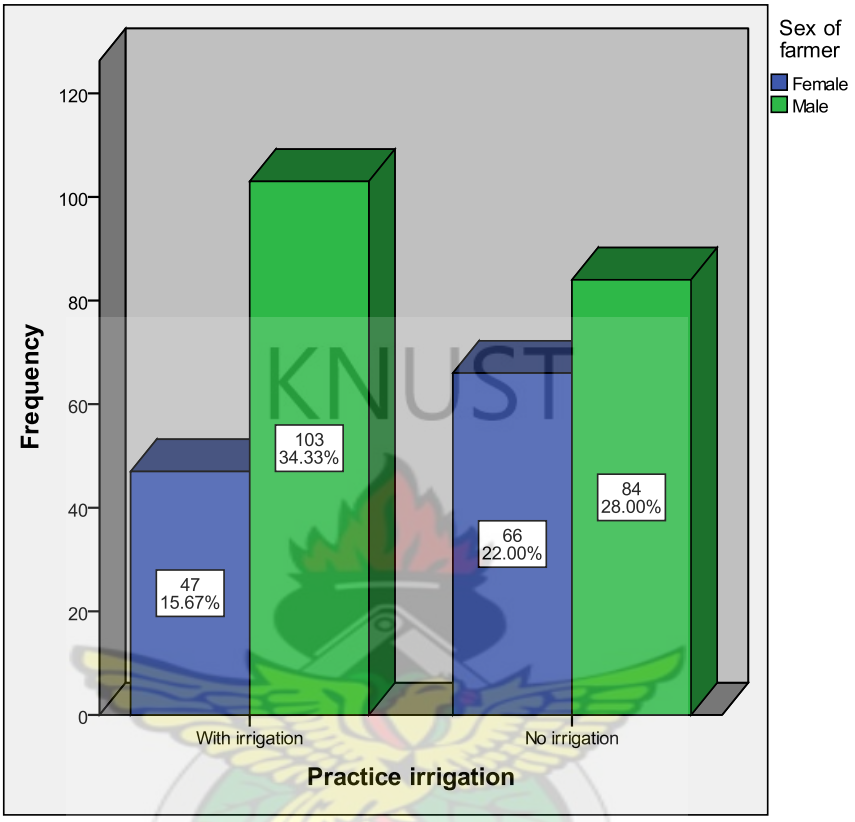

Figure 4.3: Sex of Respondents

Source: Field survey, June 2011

4.3.3 Educational Background

The graphical analysis of data on respondent's educational background in figure 4.4 reveals that 193 representing 64.33% are farmers who do not have any form of formal education whereas 13 representing 4.33% had attained SHS educational training. None of the respondents had acquired tertiary education. The data suggest that majority of the farmers in the Upper East region has never been to school and that farming could be considered as just the major profession for the illiterates who have little or no any other form of livelihood. The data which were collected from rural farming communities makes the revelation to further suggest that the basic livelihood for adults in the rural set up in the Upper East has majority as farmers who are also non literates. The data

reveals that the populations who had obtained some high degree of training and could translate theories into practice to increase output levels have refused to engage in farming for reasons worth investigating to. Figure 4.4 also suggests that the educational background of the sampled farmers for those practicing irrigation and those who do not are almost the same.

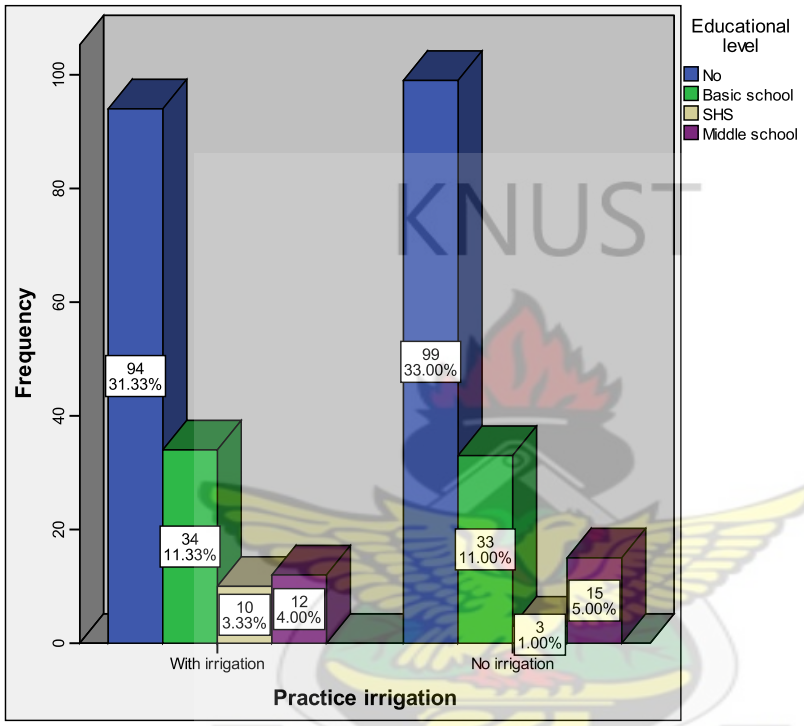

Figure 4.4: Educational Background of Respondents

Source: Field Data, 2011

4.3.4 Respondents' Household Sizes

From figure 4.5 it could be seen that the modal class of household's size lies between seven to nine (7-9) members per household for those who practice irrigation which agrees with the 2010 provisional results of the population and housing census which puts the average household size at 8.5. For farmers who do not practice irrigation majority have their household size ranging from 4 to 6. None of the farmers who do not practice irrigation reported having household size above 16 whereas 2% of those with irrigation reported to have household size above 16. This suggests that most farmers within the Upper East region which is the area of study has members between 7 to 9

which could possibly provide labour for their farming activities. Farmers who are likely not to have additional guaranteed family labour for engagement is 7.67% representing 23 of the respondents. Out of this 7.6%, only 2.6% represents farmers with irrigation whose household sizes are less than four.

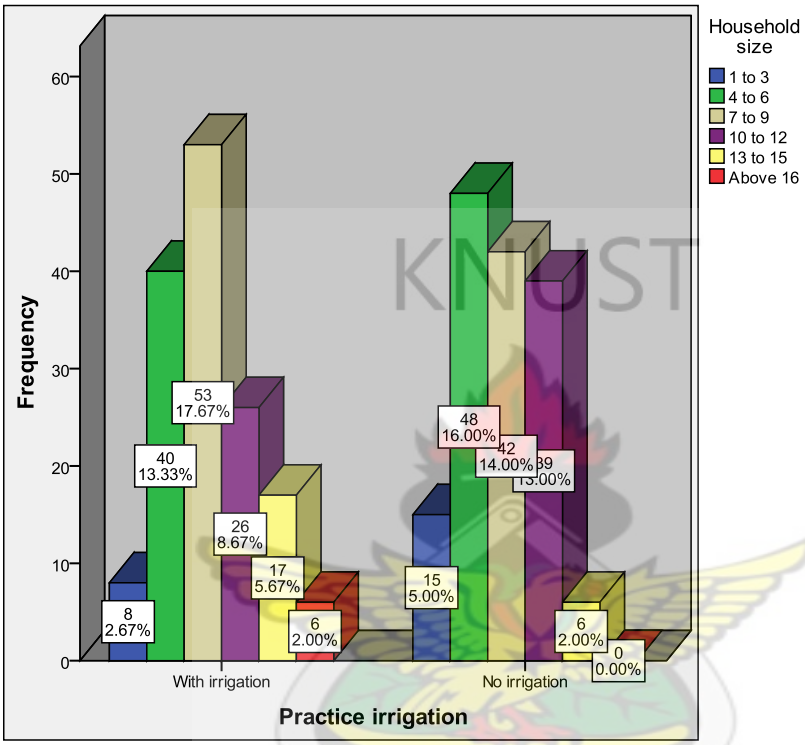

Figure 4.5: Household Size of Respondents

Source: Field Data, 2011

4.3.5 Irrigation Practice of Respondents

Table 4.1 points to the fact that the total sampled population for the study is 300 and out which 50% were farmers adopting to irrigation practice and those without irrigation practice also known as non adopters of the practice of irrigation are 50%.

Table 4.1: Irrigation Practice

Practice irrigation	Frequency	Percent	Cumulative Percent
With irrigation	150	50.0	50.0
No irrigation	150	50.0	100.0
Total	300	100.0	

Source: Field Data, 2011

This provides a fair ground for comparison in the variables being studied. The 300 farmers were sampled from three districts, a total of 100 per District in the Upper East region (Bawku municipal, Garu Tempane and Bawku west Districts).

Table 4.2: Types and levels of production of selected crops in Upper East Region from 2008 – 2010

YEARS	CROPS	MILLET	G/CORN	RICE	G/NUTS	MAIZE	COWPEA	SWEAT POTATO	SOYA BEAN
2008	YIELD TON. /HA	1.07	1.27	3.16	1.21	1.59	1.05	11.81	0.96
	AREA (HA)	65342	96602	26934	73150	23763	46907	10120	13517
	PRODUCTION (MT)	69,916	122,685	85,111	88,512	37,783	49,252	119,517	12,976
	YIELD TON. /HA	1.14	1.24	2.81	0.77	1.51	0.88	10.65	0.91
	AREA (HA)	63,927	70,536	39,833	80,066	31,039	33,530	6,853	20,320
2009	PRODUCTION (MT)	79,629	97,495	111,273	63,870	51,143	26,781	72,967	20,177
	YIELD TON. /HA	0.97	1.14	2.81	0.92	1.55	0.80	9.30	0.98
	AREA (HA)	60,720	71,165	47,361	81,450	37,921	29,403	6,940	21,510
2010	PRODUCTION (MT)	64,091.00	86,614	135,222	73,808	62,257	22,800	61,570	22,044

Source: UER MOFA, 2011

Table 4.3: Irrigation Production Coverage UER

Year/crops	Beneficiaries			Rice	Tomatoes	Onions	Pepper	Leaf veg.	Maize
	Male	Female	Total	Area (HA)	Area HA	Area (HA)	Area (HA)	Area (HA)	Area (HA)
2008/2009	9,336.0	3,o38	12,404	49.2	1,762.34	618.93	550.82	289.2	135.9
2009/2010	8,450	2,998	11,448	116.0	808.4	462.8	172.9	92.5	141.3

Source: UER, MOFA 2011

4.4 Agricultural Production in Upper East Region

The study tried to find out the levels of production and irrigation production coverage to give the situation of agricultural production in the region. From tables 4.2 and 4.3 maize production had increased from 23,763 hectares in 2008 to 37,921 representing 37.3% in 2010 and out of these 141.3 hectares was cultivated under irrigation. Out of the estimated 415,000 small holder farmers in the region as at 2010, 11,448 practice irrigation technology. What this indicates is that irrigation technology is helping to increase production volumes in agriculture and expanding on agricultural related livelihoods. The coverage of cropping area by irrigation is relatively small and calls for efforts to expand the area of cultivation under irrigation to compete with the rain fed production coverage.

4.5 Impact Areas of Irrigation Schemes

4.5.1 Access to Credit:

Comparison of farmers with and without irrigation in terms of access to credit

Credit is a livelihood asset that would contribute to the achievement of livelihood objectives and outcomes. Its availability and access to by farmers has a part to play in farmers' execution of their livelihood strategies reinforcing what Swamikannu and Berger (2009) had revealed about credit as an input to farming within the Upper East Region. Table 4.4 compared credit access by farmers between adopters and non-adopters of the practice of irrigation and the results indicates that 46% of the respondent who have adopted the practice of irrigation have access to credit and the rest of the 54% do not access credit for their farming practices. Compared to the non-adopters of irrigation that has only 39% of its members accessing credit facilities which is 7% less than the percentage of those accessing credit among respondents adopting the practice, as much as 60.7% of non adopters do not have access to credit compared to 54% of the adopters. Though the percentage difference is not much but considering the potential effect of credit as an input to farming activities, it can contribute to some extent towards the output gains between these categories of farmers. Swamikannu and Berger (2009) confirmed this in a study on the impacts of credit on welfare of the different farm types analyzed by their study revealed that access to credit could increase the income of the

irrigation farm households (small dam and big dam farms) by 56% and 82 % respectively over the baseline income level, while the income of the rain fed farm households would increase only by 22 %.

In general, out of the 300 respondents a total of 57% do not have access to credit postulating that only 42% of farmers in the region have credit support to their farming activities. This is confirming the findings of the PSIA (2005) which indicated that farmers within this ecological zone have least access to financial services as compared to the other ecological zones of Ghana. Majority of this 42% who have access to credit are adopters to irrigation practice meaning irrigation farmers are more likely to receive credit support for their activities than their colleagues who do not. Referring to the incidence of poverty in the region earlier stated in earlier chapters of this study which puts the poverty rate at 88% in 2008 if up to 58% of the farmers in the region cannot access credit to support their farming activities which basically is farming then they are still far from achieving their livelihood outcomes of improved living standards that must result from their livelihood activities already constrained by major inputs.

Table 4.4: Comparison of Farmers with and Without Irrigation in Terms of Access to Credit

Practice irrigation	**Access to credit**		
	Yes	**No**	**Total**
With irrigation	46.0%	54.0%	100.0%
Without irrigation	39.3%	60.7%	100.0%
Total	42.7%	57.3%	100.0%

Source: Field Data, 2011.

4.5.2 Access to Markets

Comparison of rain fed farms with irrigated farms in terms of access to market

Marketing of agricultural produce is as important as the production itself. Farmers will make losses and will not receive the needed gains from their activities if their produce faces a glut and pays less for their cost of production. Against this background that the

study tried to examine the differences in market access in relation to rain fed crops and irrigated crops using cross tabulation and the results shown in table 4.5 indicates the following: that 22.7% of the adopters have guaranteed markets for their produce compared to the 16.7% of non adopters. This means during production 34 farmers of the 150 have access to buyers even before the produce is ready among adopters but only 25 of such farmers who are non adopters do. During visits to farms of respondents it was noticed that most of the crops they cultivated were highly valued horticultural crops and yet have neither guaranteed market nor prices for their produce. As high as 63.7% of the farmers involved in the study do not have access to guaranteed markets but rather depend more on the unpredicted and difficult to control open market for the sales of their produce.. The level of price fluctuation is higher among irrigated crops (22%) than rain fed of (14.6%).

Table 4.5: Comparison of Rain Fed Farms with Irrigated Farms in Terms of Access to Market

Practice	Access to market			Total
	Guaranteed market	Open market	Fluctuating market	
With irrigation	22.7%	58.7%	18.6%	100.0%
No irrigation	16.7%	68.7%	14.6%	100.0%
Total	19.7%	63.7%	16.6%	100.0%

Source: Field Data, 2011

On the other hand poor and unguaranteed prices leads to a negative effect on food prices in urban set ups with short and long term elasticity of -10 to -0.89 respectively (PSIA 2005). This brings about macro level benefits where industries will demand more for agricultural produce and which leads to increases in incomes and demand for food which favours more of the rural poor who are mainly producers. Lower food prices also favours the urban poor whose expenditure share on food is 45% (GSS 2000). The results which show poor market access to small holder farmers in general implies lower food prices for consumers in general enhancing food security but also lower real income for small holder producers.

4.5.3 Access to Extension Services:

Comparison of irrigated farmers with non irrigated farmers in terms of access to extension services

To enhance the application of science and technology in food and agricultural development, access to extension service delivery is important to increase output per unit area cultivated by small scale farmers. Both farmers with and without irrigation practice were asked about their access to extension services and to further define the kind of services received. The results of the analysis in Table 4.6 shows that respondents' rain fed farms received more extension attention than their irrigated farms. Most of services received by these farmers include; training with a total of 19%, field visit with a total of 39% and technical advice with a total of 33.7% of respondents. This finding is similar to that of the NDPC (2005) which indicates extension staff contact to farmers ranging between 9% to 38% and an average of 20%. Only 15.3% of the adopters received technical training which is relevant to influence production and productivity levels. In terms of support to control disease and pest and support to input access none of the non adopters of irrigation responded that they have received any but 3.3% of the adopters did receive input support and disease control services.

Table 4.6: Comparison of Irrigated Farmers with Non-Irrigated Farmers in Terms of Access to Extension Services

Practice Irrigation	Access to extension service						Total
	Training	Field visit	Technical advice	Access to inputs	Pest and disease control	Other	
With Irrig.	15.3%	38.7%	29.3%	1.3%	2.0%	13.3%	100.0%
No Irrigation	22.7%	39.3%	38.0%	.0%	.0%	.0%	100.0%
Total	19.0%	39.0%	33.7%	.7%	1.0%	6.7%	100.0%

Source: Field Data 2011

These results suggest that extension staff concentrate more on rain fed farms than irrigated farms. The implication is that the current state of farming would improve if farmers have more extension services.

4.5.4 Land Holding Size

Comparing farmer land holding size between adopters and non adopters of irrigation

Land is an important input in farming. The amount of land available for production has a contribution towards the quantities produced and the results of the production. Comparing the land size for rain fed farms to irrigated farms the results displayed in Table 4.7 indicate that irrigated farms are of smaller holding ranging from less than 1 acre to 2 acres and not more whereas the rainfed farm sizes are small but ranging from 1 to above 5 acres. In general majority of the respondents hold farm size between 1 and 2 acres representing 34% of total respondents. This is in conformity with the contention of Van Huis and Meerman (1997) that most farmers in sub-Saharan Africa have small holdings of less than 2 ha in West Africa using traditional techniques to produce the bulk of the food. On farm size, it is worth noting that the study area is characterized by small land holdings in view of the population pressure (Atengdem and Dery, 1998).

Table 4.7: Land Size

Practice irrigation	Land size				Total
	< 1 acre	1 to 2 acres	3 to 4 acres	> 5 acres	
With irrigation	59.3%	40.7%	.0%	.0%	100.0%
Without irrigation	.0%	28.0%	22.0%	50.0%	100.0%
Total	29.7%	34.3%	11.0%	25.0%	100.0%

Source: Field Data, 2011.

4.6 Labour Engagement Comparison

4.6.1 Comparison of Rain Fed Farms with Irrigated Farms in Terms of Labour Engagement, Number of Cropping in a year, and Hunger Gaps:

It is evident from table 4.8 which displays analysis of compared data in a cross tabulation that 89.7% of both respondents engage labour on their farms and 10.3% carryout farming activities on their own.

Table 4.8: Labour Engagement

Labour engagement		Total
With irrigation	No irrigation	
87.3%	12.7%	100.0%
92.0%	8.0%	100.0%
89.7%	10.3%	100.0%

Source: Field survey, June 2011.

In comparison rain fed farmers engage more labour than irrigated farmers. Labour engagement means employment generation and increase in production.

4.6.2 Type of Labour Engagement

From table 4.9 above it is clear that farmers both irrigated and non-irrigated engage labour for their work but the form in which the engagement is made differ. Table 4.7 distinguishes the type of labour engaged by the various categories. It is realized that 67% of irrigated farmers engage hired labour as compared to 45% of the rain fed farmers. From the above findings it can be stated categorically that the use of irrigation for crop production has greater potential of generation on farm employment than rain fed farms.

Table 4.9: Type of Labour Engaged

Practice irrigation	Type of labour		Total
	Hired	Household	
With irrigation	67.2%	32.8%	100.0%
Without irrigation	45.7%	54.3%	100.0%
Total	56.1%	43.9%	100.0%

Source: Field Data, 2011.

This means that irrigation has an indirect impact on farming communities as it is able to engage more labour to raise the incomes of landless households and provide off season jobs for poor households which has no access to irrigable land. From observation it was seen that most irrigated farms were established after the major crop seasons and labour engagement would enhance the use of surplus labour after the major crop season.

4.6.3 Number of Cropping in a Year

The number of times a farmer is able to crop in a year can help reduce his venerability to the vagaries of weather, diseases and market failures and built more resiliency to shocks and threats. The comparison of cropping times in a year between farmers practicing irrigation and rain fed farmers in table 4.10 indicates that whiles farmers practicing irrigation are able to crop up to two and even three times in a year to match their colleagues in the forest, transitional and ecological zones in Ghana only 3% of the rain fed farmers are able to crop up to two times in a year.

Table 4.10: Number of Cropping times in a Year

Practice irrigation	Number of cropping in a year			Total
	Once	2 times	3 times	
With irrigation	9.3%	89.3%	1.3%	100.0%
No irrigation	98.0%	2.0%	.0%	100.0%
Total	53.7%	45.7%	.7%	100.0%

Source: Field Data, 2011.

The irrigated farmers by this reduce their risk (the degree of probability of loss) to production which includes drought, flood, pests and diseases, shifts in seasonality and soil fertility and become more stable and secured. Findings also explain further why farmers practicing irrigation engage more hired labour than those doing only rain fed farming as stated in 4.3.2.

4.6.4 Comparing Hunger Gaps

The presence of hunger is one of the signs of poverty and the MDG1 has as one of its targets to eradicated hunger by 2015. It is worth that in a study like this attempt is made to assess the level of experience of hunger by households in the study area which is said to have a poverty rate of 88% by 2007 (GPRS II, 2009). In attempt to assess the length of hunger gap among farmers being studied they were asked to state the number of months that they experience hunger. The result is found in table 4.11 where results of the respondents are compared among farmers with irrigation and farmers without irrigation. From the table it is realised that as much as 25.3% do not experience hunger at all in a year, but almost the same percentage of respondents that is 26% experience hunger between 5 to 6 months. Majority of the farmers who do not practice irrigation experience hunger between 3 to 4 months, they represent 46% of their respondents, but none of them answered for absence of hunger in their households.

Table 4.11: Number of Months without Food

Practice irrigation	Number of months without food						Total
	0	1 month	1 and 1/2 months	2 months	3 to 4 months	5 to 6 months	
With irrigation	25.3%	13.3%	1.3%	31.3%	20.0%	8.7%	100.0%
No irrigation	.0%	14.0%	.0%	14.0%	46.0%	26.0%	100.0%
Total	12.7%	13.7%	.7%	22.7%	33.0%	17.3%	100.0%

Source: Field Data, 2011

The direct impact of irrigation on farmer household is very evident here that almost the same percentage of households, an average of 25.5% from adopters and non adopters of

irrigation have different experience where adopters do not experience hunger gaps but the same percentage of non adopters experience up to 6 months of hunger.

4.7 Yield Comparison: Rain Fed Farms with Irrigated Farms

Table 4.12 is comparing yields per hectare of different crops between irrigated farms and non irrigated farms. From the available data the yields in tonnage per hectare is varied between rain fed farms and irrigated farms. Table 4.12 indicates that on the same size of land produced under irrigation and rain fed, maize under irrigation would yield 2.6 times higher than cultivation under rain fed.

Table 4.12: Yield for Some Selected Crops

Crop	Irrigated farm Yield (tons/ha)	Rain fed farm Yield (tons/ha)
Tomatoes	10.5	6.5
Pepper	3.0	1.2
Leafy Vegetables	2.0	1.5
Onions	10-12	6-8
Maize	4.0	1.5
Rice	4.5	2.8
Millet	2.1	1.1
Okro	3.8	2.5

Source: MOFA, 2011.

For tomatoes, irrigated farms will yield 1.6 times higher than rain fed farms on the same sizes of land with all things held constant except irrigation. The finding is in consonance with the FAO who suggest that irrigation can increase yields for most crops by 100 to 400%, and that higher, less risky and more continuous levels of rural employment and income result from the higher cropping intensities, yields and more intensive and higher value crops and cultivation techniques of irrigated compared to rain-fed agriculture FAO, (1996) in Smith (2004)

4.8 Effect of irrigation Practices on Livelihoods among Households and Communities

4.8.1 Benefits to the Household

The study also tried to find out if irrigation had some direct contribution to households especially on some poverty indicators and the response is presented in table 4.13. The results indicates that irrigation practice has an influence on these indicators as 289 representing 96.3% respondents had mentioned its benefits in terms food security, employment, income, wealth creation, increased spending and improved health which contributes to the total wellbeing of individuals. Rest of the 3.7% did not respond at all to any of the responses. From the table, 66% agrees that irrigation practice promotes food security to the households, 13% said it contributes to income generation, 7.3% said it contributes to improved health and only 0.7% said it supports wealth creation. Their responses are not different from the report of Lipton and Litchfield (2003).

Table 4.13: Benefits to the Household

Benefits to the household	Frequency	Percent	Cumulative Percent
Food security	198	66.0	68.5
Employment	22	7.3	76.1
Income	39	13.0	89.6
Wealth creation	2	.7	90.3
Increase spending	3	1.0	91.3
Improve health	22	7.3	99.0
Other	3	1.0	100.0
Total	289	96.3	
Missing System	11	3.7	
Total	300	100.0	

Source: Field Data, 2011

4.8.2 Benefits to the Community and District

Irrigation has direct and indirect impacts at different levels. At the micro level the impact is on individuals and households and at the meso level it is on the community and the district. Tables 4.14 and 4.15 show responses from farmers contacted on how irrigation benefits the meso level. For the community level, 53% respondents said it contributes to food security being the highest percentage of respondents confirming their response even at the household level with the highest percentage response of 66% and with 57% responses on food security also at the district level.

Table 4.14: Benefits to the Community

Benefits to the community	Frequency	Percent
Employment	82	27.3
Food availability	160	53.3
Livestock production	15	5.0
Water for construction	24	8.0
Community asset building	6	2.0
Total	287	95.7
Missing System	13	4.3
Total	300	100.0

Source: Field Data, 2011

Table 4.15: Benefits to the District

Benefits to the district	Frequency	Percent
Food prices	27	9.0
Food export	25	8.3
Food security	172	57.3
Agro based enterprises	1	.3
Reduce migration	63	21.0
Total	288	96.0
Missing System	12	4.0
Total	300	100.0

Source: Field Data, 2011.

This is an indication that the first impact of irrigation on poverty is food security, at both the micro and meso levels. At the district level respondent said irrigation practice reduces migration with 21% of respondents agreeing to that and 9% indicate that it influences food prices which the PSIA (2005) postulate that it has a negative correlation on rural smallholder farmer's income and a positive correlation on urban poverty and industrial growth.

4.9 Challenges and Potentials for Irrigation Development

During the study a number of challenges and potentials for developing and improving irrigation technology in the study area were revealed. These were identified through observation, institutional data and focus group discussions. The observable challenges were that though many communities were practicing irrigation their sources of water supply were very informal ranging from wells to ponds and the farmer had to fetch this water and carry it around the crops to precipitate suggesting their irrigated farm sizes to be smaller due to the fatigue involved.

Farmers created wells and ponds on each farmers land revealing the environmental hazard caused especially when flooded during the raining season causing drowning and further soil nutrient erosion into such ponds and wells. Figure 4.7 shows the water

supply for most small scale irrigation farms and 4.8 showing improvised watering cans used for applying water to crops.

Figure 4.6: Source of Irrigation Water

Figure 4.7: Mode of Water Application

Source field survey, 2011

The potentials observed and also mentioned during focus group discussions indicated that the area has vast irrigable lands, high concentration of network of rivers for further irrigation development and increased farmer interest and demand for irrigation technology.

4.9.1 Ways of Improving Irrigation Technology Development in the Upper East

1. In soliciting information for irrigation technology improved MOFA and GIDA including farmers and other stake holders made the following suggestions:
2. Rehabilitate all breached dams and dugout in the region to meet the growing standards on innovative irrigation practice
3. Develop enough tube wells in valleys to close the short fall of larger dams and dugouts
4. Expand the development of pump stations through river diversion as found in Tiegu and Yarigu Irrigation projects in the Bawku west
5. Support farmers living along the White Volta to acquire water pumps for irrigation farming
6. Sensitise more farmers to adopt irrigation technology as an innovation to agricultural modernisation
7. Decentralising the Irrigation Development Authority to create grassroots level offices within Northern Ghana

4.10 Testing the Impact of Small Scale Irrigation Schemes on Livelihood of Farmers

Test of Hypotheses

1. To test the hypothesis that irrigation farmers hire more labour than rain fed farmers, the appropriate null and alternative hypotheses are;

   Null Hypothesis (H0): Irrigation farmers do not hire more labour than rain fed farmers.

   Alternative Hypothesis (H1): Irrigation farmers hire more labour than rain fed farmers.

Table 4.16 below shows the group statistics for the number of labour hired for both irrigation and rain fed farmers whiles table 4.15 shows the independent sample t-test results.

Table 4.16: Group Statistics for Number of Labour Hired

	Practice irrigation	N	Mean	Std. Deviation	Std. Error Mean
Number of labour hired	Yes	150	7.25	5.608	.458
	No	150	5.83	5.537	.452

Source: Field, 2011

4.10.1 Independent Samples Test

Table 4.17: Independent sample test

Dependent variables	Assumptions	t-test for Equality of Means				95% Confidence Interval of the Difference	
		t	df	(p-value)	Mean Difference	Lower	Upper
Number of labour hired	Equal variances assumed	2.196	298	.029	1.413	.147	2.680
	Equal variances not assumed	2.196	297.9	.029	1.413	.147	2.680

Source: Field survey, June 2011

From Table 4.17 above, the average number of labour hired by irrigation farmers differ significantly from the average number of labour hired by rain fed farmers (t=2.196, p-value=0.029) at the significance level of 0.05. Thus, the hypothesis that irrigation farmers hire more labour than rain fed farmers is substantiated.

2. To test the hypothesis that rain fed farmers experience more hunger gaps than irrigation farmers, the appropriate null and alternative hypotheses are;

Null Hypothesis (H0): Rain fed farmers do not experience more hunger gaps than irrigation farmers.

Alternative Hypothesis (H1): Rain fed farmers experience more hunger gaps than irrigation farmers.

Table 4.18: Hunger Gaps Experiences

Practice irrigation	Hunger gaps experiences		Total
	Yes	No	
Yes	117	31	148
	79.1%	20.9%	100.0%
No	144	6	150
	96.0%	4.0%	100.0%
Total	261	37	298
	87.6%	12.4%	100.0%

Source: Field Data, 2011

Table 4.19: Chi-Square Tests

Statistics	Value	df	Sig. prob (p-value)
Pearson Chi-Square	19.672[a]	1	.000
Continuity Correction[b]	18.145	1	.000
Likelihood Ratio	21.278	1	.000
N of Valid Cases	298		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 18.38.

b. Computed only for a 2x2 table

Source: Field Data, 2011

Table 4.19 shows the chi-square test for the above hypothesis at 95% level of confidence. The value of the test statistic or the p-value is 0.000 which is less than the significance level (0.05). Therefore the sample does not provide enough evidence to accept the null hypothesis. Hence we reject the null hypothesis and conclude that, rain

fed farmers experience more hunger gaps than irrigation farmers at 95% level of confidence.

CHAPTER FIVE
SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

5.0 Introduction

Based on the analysis and discussions of the data collected in chapter four, chapter five goes on to discuss the major findings of the study and tries to make a reflection over the research questions and objectives to establish how far these are achieved. These discussions lead to the provision of recommendations and conclusions about the whole study outcome.

5.1 Summary of Findings

Based on the study outcome, the following findings are made:

5.1.1 Characteristics of Farmers

majority of farmers from the Upper East Region are within the ages of 27 to 50 representing 69.66% with a higher population being the active working force between the ages of 33 to 38 representing 33.33%.

The study shows that 62.33% of farmers in the region are men and 37.67% being women. This suggests that farming is male dominated livelihood around the Upper East region because the sampled population of farmers who are men is almost double that of women. The gender disaggregation of the figures is more revealing as it epitomizes the gender disparities that characterize the study area and the north in general (Karbo and Bruce, 2003; Atengdem and Dery, 1998).

The farming populace is dominated by non literates with 64.33% not having any form of formal education. The study did not find any literate above SHS and gives the picture that people farming as a vocation belongs to the non literates around rural communities.

On household sizes it was found that the common household size for most farmers is between 7 to 9 representing 31.7% of the total respondents and provided labour to

farmers they lived with. About 89.7% of both respondents engaged labour on their farms and 10.3% carryout farming activities on their own. It was an interesting revelation to realize that rain fed farmers engaged more labour than irrigated farmers but irrigated farmers rather hired more labour than rain fed farmers.

Types and Forms of Irrigation Schemes Practiced

From the field visits and observation it was found out that households were using different types of irrigation system. There had been a number of dams and dugouts established and dotted among communities in the region that farmers have taken advantage of to carryout irrigation activities. However most of these dams were constructed without structures to support irrigation like canals and pipes constructed and fitted. They were either meant for just constructional and livestock watering and not irrigation in mind during constructions but the demand for irrigation infrastructure had compelled farmers to use different modes of accessing water for crops around these facilities. Most rivers and valleys had been taken over by farmers during the dry season to cultivate crops using irrigation. The commonest method was the surface irrigation where fields are watered using gravity systems or hand watering using cans. Those who could afford used fuel driven water pumps to apply water to crops from wells or rivers and streams. There were few sights that used sprinklers connected to drums of water a technology promoted by World Vision International, Ghana but it was not cost effective according to farmers due to the machines used as compared to farmers who used the surface mode and so the technology is not widely used. In other few occasions treadle pumps were used and again only in isolated cases and the reason is that it is more labour intensive to pump water using them and difficult to cover wider areas.

5.1.2 Levels of Agricultural Production in the Region

Level of production in terms of land area had increased especially within rain fed agriculture. There is less developed irrigable land to complement rain fed farms. Farmers produce more horticultural crops under irrigation than cereal crops within the region. Effort is needed to increase production under irrigation technology.

5.1.3 Access to Credit and Markets

Farmers in the Upper East region have little access to credit as only 46% of the sample who has adopted the practice of irrigation has access to credit compared to the non-adopters of irrigation that has only 39% of its members accessing credit facilities. Farmers practicing irrigation are more likely to receive credit support for their activities than their colleagues who do not.

During visits to farms of respondents of irrigation practice it was noticed that most of the crops they cultivated were highly valued horticultural crops including water melon, onions and tomatoes and this might have contributed to the fact that they had access to guaranteed markets and prices for their produce than their counterparts practicing only rain fed farming. The level of price fluctuation is higher among irrigated crops than rain fed crops. The results which show poor market access to small holder farmers in general implies lower food prices for consumers in general enhancing food security but also lower real income for small holder producers.

5.1.4 Access to Extension Services

With regards to access to agricultural extension services, the results of the analysis shows that respondents' rain fed farms received more extension attention than their irrigated farms. This further suggests that extension staff concentrate more on rain fed farms than irrigated farms. Input support and disease control were services that irrigated farmers benefited from extension services provider which farmers without the practice reported never received. The response was insignificant representing 3.3% of the total respondents of farmers with irrigation. Generally extension officers revealed that they had higher farmer to extension officer ratios and lacked appropriate transport and tools and equipment to support their work.

5.1.5 Farm Labour Engagement

The findings indicates that irrigated farms are of smaller holding ranging from less than 1 acre to 2 acres and not more where as the rain fed farm sizes are small but ranging from 1 to above 5 acres. Though with small land holding sizes, farmers still engage labour on their farms with the irrigated farms engaging more on farm labour. It is realized that 67% of irrigated farmers engage hired labour as compared to 45% of the rain fed farmers.

5.1.6 Length of Employment

Farmers practicing irrigation are able to crop up to 2 and even three times in a year to match their colleagues in the forest, transitional and ecological zones in Ghana only 3% of the rain fed farmers are able to crop up to 2 times in a year and the majority cropping just once in a year. It was revealed those farmers who also practice irrigation technology stay longer in the farming business than those who do not. Most irrigation adopters said they crop up for as long as 9 to 10 months whilst non adopters are in the business for only 3 to 4 months.

5.1.7 Food Security

Food insecurity is more prevalent among farmers who do not practice irrigation. This is because as compared to non-irrigated farmers who have up to 26% experience hunger between 5 to 6 months, adopters of irrigation technology have as much as 26% of its population not experiencing hunger at all in a year. All farmers who do not practice irrigation have food shortages within the year but the length is varied among different households ranging from 1 to 6 months.

5.1.8 Influence of Irrigation on Output

If all other factors of production are held constant for both rain fed and irrigated farms, the yields are going to be higher under irrigated than rain fed farms. The findings indicate that on the same size of land produced under irrigation and rain fed, maize under irrigation would yield 2.6 times (260%) higher than cultivation under rain fed.

For tomatoes, irrigated farms will yield 1.6 times higher than rain fed farms on the same sizes of land with all things held constant except irrigation.

On the whole the results indicates that irrigation practice has an influence on the studied poverty reducing indicators as 289 representing 96.3% respondents had mentioned its benefits in terms food security, employment, income, wealth creation, increase spending and improve health which contributes to the total wellbeing of individuals. There is an indication that the first impact of irrigation on poverty is food security, at both the micro and meso levels.

There is positive correlation among irrigation practice, farm based employment and food security. Where it came out that, adopters to irrigation employed more labour and experience little or no months of food shortages.

5.1.9 Challenges Associated with Small Scale Irrigation

Though the findings proved that irrigation has impact on poverty and livelihood development, it proved that this practice was on with some kinds of difficulty within the communities and farmers. It showed that water points for irrigation are woefully inadequate and farmers sought for different innovative forms of surface water application forms. Farmers use indigenous labour intensive methods for applying the technology which has a correlation with their land holding sizes which are small of even less than an acre.

The water quality for irrigation cannot be said to be the best looking at the different sources of the water used for application which has health implications. There are several rivers networked around the study area showing the presence of enough irrigable lands and higher number of dams and dugouts giving a greater opportunity for developing irrigation to the best level to promote the benefits shown in the study.

High incidence of postharvest losses for onion, watermelon, tomatoes and other vegetable farmers leads to decrease in economic gains from farming and marketing of

such crops. Also lack of guaranteed markets and prices for farmers produce decrease the gains from cultivated such crops using irrigation or rain fed.

5.2 Recommendations

Based on the findings and the conclusion the researcher makes these recommendations. The benefits and gains of irrigation are many but only limited a number of farmers and communities have access and control of such resource as irrigable land and water. Therefore government Agencies, institutions, and departments and Non-governmental organisations, Civil society (e.g. Community based organisations) individual benevolent and philanthropic organisation who also redirect more of their resources in promoting irrigation farming among farmers within the Northern Ghana and especially the Upper east region to close the gaps created by over reliance on rain fed agriculture and reduce their vulnerability levels resulting from farming failures.

Marketing of farm produce is with some kind of challenges and the implication is that the small farm holder does not get paid the motivating prices for their produce and this widens their vulnerability and limits their asset gains. Therefore marketing systems and structures should be established and developed to enhance the marketing of agricultural produce especially for rural communities. This should include value chain linkages, road infrastructural development and other transport requirements, post harvest infrastructure like cold rooms for the storage of highly perishable horticultural crops produced mostly by irrigation (tomatoes, water melon, leafy and bulb vegetables). Therefore, MoFA, research institutions and the private sector should collaborate to develop and sustain value chain systems for major cash crops in the region

Extension service provision should not be limited to the major crop seasonal activities but to extend to the off seasonal farming activities through irrigation. This will promote increase in productivity and production among farming communities. Extension service providers should also now focus on disease and pest control as well as promoting access to input supply which seems to be left out as revealed by the results of the study where only 3% of farmers access those services.

Farmers with access to credit were limited only 49% and 36% for irrigated and non irrigated farms respectively. There is the need to step up credit facilities to the rural

small holder farmer to strength their farming activities. Banks and other Microfinance institutions should venture and expand their credit products to small holder rural farmers especially for irrigation farmers because they have much control of the crop life and can guarantee limited risk to their farm. The products should not be that extortive to scare away such farmers to access the facility.

The environmental degradation made by the practice by separated household trying to open to water sources on their separate pieces of land is harmful and should be controlled. Sustainable practices for perennial use of water should be enhanced. Also community ownership systems and structures supporting irrigation be strengthened and improved. Good agricultural practices with conservation technologies like protection of river bodies should be encouraged among farm families by the environmental protection Agency, MOFA and NGOs promoting food security.

Post harvest losses should be reduced among farmers especially the irrigated crops which are more perishable. Research institutions should come out with improved ways of prolonging the shelf life of tomatoes, onions, watermelon and leafy vegetables to reduce losses and increase better market competition for such crops. Post harvest infrastructure is relevant at irrigation sites where farmers can hire to store perishable products from the farms. There both the public and private sector should attempt to invest in postharvest infrastructure to minimise losses after harvest. Researchers should come out with other scientific ways of improving the shell life of highly perishable products where enzyme reactions can be stopped or slowed to minimise over ripening which leads to spoilage.

Here also the recommendations and suggestions by the other stakeholders are relevant. That is:

1. Rehabilitate all breached dams and dugout in the region to meet the growing standards on innovative irrigation practice
2. Develop enough tube wells in valleys to close the short fall of larger dams and dugouts

3. Expand the development of pump stations through river diversion as found in Tiegu Yarigu Irrigation project in the Bawku west
4. Support farmers living along the White Volta to acquire water pumps for irrigation farming
5. Sensitise more farmers to adopt irrigation technology as an innovation to agricultural modernisation
6. Decentralising the Irrigation Development Authority to create grassroots level offices within Northern Ghana

5.3 Conclusions

Small scale irrigation in the Upper East region remains the major source of employment through crop cultivation in the dry season. Small scale irrigation provides employment and income for communities and so encourages communities and farm families to try to acquire households and community irrigation sites through food for work, communal labour and institutional support. Farmers use wells, dugouts, treadle pumps, pumping machines, and running water from rivers to provide supplementary water supply to crops during droughts and dry seasons. The study revealed that irrigation is useful towards the development of sustainable livelihoods among small holder farmers for poverty reduction within the country.

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APPENDICES

Appendix A

Kwame Nkrumah University of Science and Technology

Department of Planning

Student Research Work towards the attainment of MSc. Development policy and Planning

Checklist for farmer data collection

No	Indicator	Description	Option	Remarks
1	Name of community	(1)with irrigation (2)without irrigation (3)unknown		
2	Sex of Farmer	(1) Female (2) male		
3	Age of farmer	(1) 15-20 (2) 21-26 (3)27-32 (4) 33-38 (5) 39-44 (6) 45-50 (7) above 50		
4	Educational Level	(1)No, (2)Basic school, (3)SHS (4)middle school, (5)tertiary		
5	Household size	(1)1to3, (2)4to6, (3)7to 9, (4) 10 to 12, (5)13 to 15 (6)above 16		
6	Practice irrigation	(1) yes, (2)no		
7	Use irrigation facility	(1)yes (2) no (3)not certain		
8	Type of facility	1)dam with canals 2) dam without canals 3) dugout 4) river 5) well 6) borehole 7) others		
9	Other uses of irrigation facility	(1)construction (2)livestock (3) fishing (4)recreation		
10	Land size for rain fed farm	(1)1to 2 acres, (2)3 to 4acres, (3) 5 to 6 (4) 7 to 9 (5)10 to 12 (6) above 12		
11	Land size for irrigated farm	(1)$\frac{1}{4}$ acre, (2) ½ acre, (3) $\frac{3}{4}$ acre (4) 1acre (5)1 $\frac{1}{2}$ (6)2acres and above		
12	Crops for rain fed	(1)maize (2)millet, (3)leafy vegetables (4)onions (5) sorghum (6)soyabeans (7)beans and nut (8)rice (9) water melon (10)tomatoes (11)pepper (12)tobacco (13)others		
13	Crops irrigated farms	(1)maize (2)millet (3)leafy vegetables (4)onions (5) sorghum (6) soya beans (7)beans and nut (8)rice (9) water melon (10)tomatoes (11)pepper (12)tobacco (13)others		
14	Labour engagement	(1)yes (2)no		
15	Type of labour	(1)Hired (2)household		
16	Number of labour used	1)1 to 3 (2) 4 to 6 (3)7 to 10 (4)11 to 13 (5)14 to 17 (6)18 to 20		
17	Number of labour hired – rain fed farms	(1)1 to 3, (2) 4 to 6, (3)7 to 10, (4)11 to 13, (5) 14 to 17, (6)18 to 20, (7) above 20		
18	Number of labour hired – irrigated farms	(1)1 to 3 (2) 4 to 6 (3)7 to 10 (4)11 to 13 (5) 14 to 17 (6)18 to 20 (7) above 20		
19	Inputs used	(1)seed, (2)fertilizer, (3)disease and pest control, (4) land preparation, (5) water (6) others		

No	Indicator	Description		Option	Remarks
20	Use of labour saving inputs for irrigated farms	(1)yes (2)no			
21	Type of labour saving inputs	(1)weedicides (2)water pumping machines (3)harvestor , (4)-others			
22	Access to credit for rain fed	(1)yes (2)No			
23	Access to credit for irrigated farm	(1)yes, (2)no			
24	Access to market rain fed crops	(1)guaranteed market, (2)open market, (3)guaranteed prices, (4)open prices, (5)higher prices, (6)low prices, (7) fluctuating market, (8)others			
25	Access to market Irrigated crops	(1)guaranteed market, (2)open market, (3)guaranteed prices, (4)open prices, (5)higher prices, (6)low prices (7) fluctuating market, (8)others			
26	Access to extension for irrigated farms	(1)training (2)field visit (3) Technical advice (4)access to inputs (5)pest and disease control (6)others			
27	Access to extension Rain fed farms	(1)training (2)field visit (3)Technical advice, (4)access to inputs (5)pest and disease control (6)others			
28	Source of water for irrigation	(1)dams (2)dugout (3)rivers (4)streams, (5)wells, (6)borehole (7)others			
29	Application modes	(1)drawing by hand, (2)gravity from canals, (3)pumping machine, generator (4) pumping treadle (soka pump), (5)sprinkling host (6) others			
30	Hunger gaps experiences	(1)yes, (2) no			
31	Number of months without food	(1)0, (2) 1month, (3)1 $\frac{1}{2}$ months, (4)2 months, (5)3to 4 months, (6)5 to 6 months, (7) above, (8) months			
32	Asset building	(1)yes, (2)no			
33	Type of assets acquired	(1)housing, (2)household, (3) equipment, (4)bicycle, (5)motor, (6)education, (7)savings, (8)land, (9)relationships, (10)others			
34	Irrigation related livelihoods	(1)cropping,(2) farm labour, (3)marketing, (4)security, (5)storage			
35	Cost of production/	Land Seed Fertilizer Pesticides Fungicides Labour Storage Land preparation Transport Others	……... …… …… …… …… …… …… …… ……	**Total**	

No	Indicator	description		Option	Remarks
36	Income from sales	Onions Tomatoes Pepper Maize Watermelon Leafy vegetables Other total	…….. ……. …… …… …….. …….. …….	Total	
37	Number of cropping in a year	(1)1, (2)2 times (3)3 times, (4)4 times, (5)5 times			
38	Number of months without work (farming)	(1)0, (2)1 to 2 months, (3)3 to 4 months (4)5 to 6 months, (5)7 to 8 months (6)above (8) months			
39	Off season migration without irrigation	(1)yes, (2)no			
40	Benefits to the House hold	(1)food security, (2)employment, (3)income, (4) wealth creation, (5)increase spending, (6)Improve health (7)others			
41	Benefits to the community	(1)employment, (2)food availability, (3)livestock production, (4)water for construction, (4)community asset building			
42	Benefits to the district	(1)food prices, (2)food export, (3)food security, (4) agro based enterprises, (5)reduce migration			

Name of Community:

Date of Data collection:

Kwame Nkrumah University of Science and Technology

Department of Planning

Student Research Work

Focus Group Interview guide

1) What is the name of this community?
2) Do you have a source of irrigation?
3) Why has irrigation become necessary?
4) Who has access to irrigable lands?
5) How is the land for irrigation acquired?
6) What is the ratio of men to women in terms of practice in irrigation farming?
7) What types of crops do both men and women engage?
8) What does a community without irrigation practice loose?
9) What does a community practicing irrigation gain?
10) What is the difference between a house hold with irrigation and a house hold with out irrigation?
11) Approximately how much can one earn from irrigation as labour offered?
12) Incase your community has no irrigation facility, is it possible to access it in a different community?
13) What support systems does an irrigation facility provide to house holds and communities?
14) Suggest ways to improve small scale irrigation development in the District.

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF PLANNING

STUDENT RESEARCH WORK

Interview Guide for Extension Officers

1) What are the importance of Small scale irrigation as a source of livelihood development to communities in this District

……

……

……

2) When does farmers mostly engage in irrigation farming

……

……

……

3) What types of water supply system are commonly used?

……

……

……

4) State the source of water for application

……

……

5) Are you able to provide recommended technical training to irrigation farmers?

6) What type of training do you offer irrigation farmers

……

……

……

7) What support a part from training do irrigation farmers accessed from you

……

……

……

8) Are there differences in terms of yield between irrigated farms and non irrigated farms per acre?

Irrigated farm		**Non irrigated farm**	
Crop	**Yield**	**Crop**	**Yield**
Tomatoes		Tomatoes	
Pepper		Pepper	
Leafy vegetables		Leafy vegetables	
Cabbage		Cabbage	
Onions		Onions	
Maize		Maize	
Rice		Rice	
Maize		Maize	
Others		Others	
		Crop	

9) Does your organization provide input support to irrigation farmers? If yes, what type of inputs are they?

10) Suggest ways to improve small scale irrigation development in the District.

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF PLANNING

STUDENT RESEARCH WORK

Questionnaire for Irrigation Development Staff

1) Are there differences in terms of yield between irrigated farms and non irrigated farms per acre?

Irrigated farm		**Non irrigated farm**	
Crop	**Yield**	**Crop**	**Yield**
Tomatoes		Tomatoes	
Pepper		Pepper	
Leafy vegetables		Leafy vegetables	
Cabbage		Cabbage	
Onions		Onions	
Maize		Maize	
Rice		Rice	
Maize		Maize	
Others		Others	
		Crop	

2) What is the total number of reservoirs in the region by district?

District	**Dugouts**	**Dams**	**Total**
Garu Tempane			
Bawku West			
Bolgatanga Municipal			
Bawku Municipal			
Talensi Nabdam			
Kasena Nankana East			
Kasena Nakana West			
Bolgatanga Municipal			
Total			

3) What are the number of communities that practice irrigation by other means without using dams and dugouts?

District	**Using streams**	**Using rivers**	**Using wells**	**boreholes**
Garu Tempane				
Bawku West				
Bolgatanga Municipal				
Bawku Municipal				
Talensi Nabdam				
Kasena Nankana East				
Kasena Nakana West				
Builsa				
Bongo				

4) What is the way forward for small scale irrigation development in the upper east region?

Appendix B

1. Chi-Square Test Statistic:

$$X^2 = \sum \left[\frac{(f_o - f_e)^2}{f_e} \right]$$

With $k-1$ degrees of freedom, where:

k is the number of categories,

f_o is an observed frequency in a particular category,

f_e is an expected frequency in a particular category.

2. Test Statistic for Comparing Means

$$T = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

Where:

$\overline{X}_1$ *and* $\overline{X}_2$ are the sample means of group1 and group2 respectively,

S_1^2 *and* S_2^2 are the sample variances of group1 and group2 respectively,

n_1 *and* n_2 are the sample sizes of group1 and group2 respectively.