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IMPLICATIONS OF IRRIGATION FARMING ON LIVELIHOODS OF SMALL HOLDER FARMER HOUSEHOLDS IN NADOWLI-KALEO DISTRICT

KANTAKYENE DIANA TAMPUORI

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IMPLICATIONS OF IRRIGATION FARMING ON LIVELIHOODS OF SMALL HOLDER FARMER HOUSEHOLDS IN NADOWLI-KALEO DISTRICT

BY

KANTAKYENE DIANA TAMPUORI

A THESIS SUBMITTED TO THE DEPARTMENT OF ENVIRONMENT AND RESOURCE STUDIES OF FACULTY OF INTEGRATED DEVELOPMENT STUDIES, UNIVERSITY FOR DEVELOPMENT STUDIES, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN ENVIRONMENT AND RESOURCE MANAGEMENT

JULY 2022

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DECLARATION

Candidate's Declaration

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

Candidate's Signature  Date 23rd November, 2022.

Name: Kantakyene Tampuori Diana

Supervisors' Declaration

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

Supervisor's Signature  .Date 23rd November, 2022.

Name: Dr. Bukari Francis Issahaku Malongza

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DEDICATION

Dedicated to my Parents, Husband and Children

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ABSTRACT

This thesis investigated into the implications of irrigation farming on livelihoods of small holder farmer households in Nadowli-Kaleo District of the Upper West Region of Ghana. The main objective was to ascertain the implications of irrigation farming on livelihoods. Both explanatory and descriptive research designs were employed, involving quantitative and qualitative approaches. The study found that longer duration of the dry season was a major condition influencing the adoption of irrigation farming by households. It was also revealed that small-scale irrigated farmlands are generally less than one acre, characterized by the use of locally constructed canals to channel water from surface water bodies, as well as the use of hand dug wells. The main aim of households engaged in irrigation farming is to generate income during the dry season and to promote food security. High cost of inputs and information on how to acquire the right inputs were found to be the major challenges of irrigation farming. It was recommended that the Ghana Irrigation Development Authority should adopt participatory approaches in the planning and implementation of small-scale irrigation farming for sustainable livelihood promotion.

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LIST OF ACRONYMS

DADU - District Agriculture Development Unit

GIDA- Ghana Irrigation Development Authority

GSS - Ghana Statistical Service

GSOP - Ghana Social Opportunities Programme

GLSS - Ghana Living Standard Survey

IFAD - International Fund for Agricultural Development

MOFA - Ministry of Food and Agriculture

MENR - Ministry of Environment and Natural Resources

PHC - Population and Housing Census

SSI - Small Scale Irrigation

SSIDs - Small Scale Irrigation Dams

SPSS - Statistical Package for Social Scientist

UNEP - United Nations Environment Programme

WFP - World Food Organization

WWF - World Wide Fund for Nature

FAOSTAT-Food and Agricultural Organisation Corporate Statistical Database

DFID- Department for International Development

FAO- Food and Agriculture Organisation

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ISSER-Institute for Statistical, Social and Economic Research

WUA- Water Users Association

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CHAPTER ONE

INTRODUCTION

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1.1 Background to the Study

In Africa, agriculture forms the backbone of most of the continent's economies, providing about 60% of all employment (Kidane, Mekonnen, Teketey, 2016, as cited in Mengistie2016). According to (Harris, 2019), irrigation is the process of bringing water to dry land through pipes, hoses, ditches or other artificial means. Irrigated lands usually contain crops, grass or vegetation that would not usually receive enough water from rainfall or other natural sources. In tropical areas with single maxima rainfall regimes, the reason to irrigate a portion of land could be due to the onset of the dry season. In other areas land is irrigated because of less-than-average amounts of rainfall, or it is a desert area, where irrigation must be done because the land might never receive enough rainfall on its own unless taken from nearby lakes, reservoirs, rivers or wells (Harris, 2019).

According to the International Food Policy Research Institute [IFPRI] (2010), because a greater part of Africa experiences a tropical continental climate, the total area equipped for irrigation is slightly more than 13 million hectares and makes up just 6 percent of the total cultivated area. IFPRI (2010) further asserts that 85% of Africa's poor live in rural areas and mostly depend on agriculture for

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their livelihoods, making agricultural development a key to ending poverty and improving livelihoods on the continent. However, because of the arid and semi-arid conditions, irrigational development has been prioritized by many development organizations for increased investments in the region for poverty reduction.

According to Namara et al. (2010), there are various typologies of irrigation. The authors describe public or formal surface irrigation systems as schemes which are basically operated and maintained by the Ghana Irrigation Development Authority (GIDA) or the Irrigation Company of Upper Region (ICOUR). Here fees are charged to beneficiaries for irrigation services for the delivery of water. Such formal irrigation projects were initiated by the Government of Ghana in the 1960s. There are now about 22 completed public irrigation projects in the country (Namara et al., 2010).

In the non-formal sector, GIDA (2014) identifies small reservoir-based communal irrigation systems, which involve substantial contribution of beneficiary communities, but could involve GIDA, donors or private contractors as stakeholders, playing some roles such as the initiation of the project, financing and physical construction. The influence of communal Water User Associations (WUAs) is significant in such projects in the aspects of managing and performing operation and maintenance activities. However, how the typologies of irrigation

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projects vary over space in Ghana is of further research interest, since the information above is too general.

In Ghana, over the years there have been numerous efforts to improve livelihoods with a focus on the establishment of several small-scale irrigation sites dotted across the country especially the Northern sector. The aim of the government is to improve livelihood and ensure a sustained food security. Despite this progress in poverty reduction, the Ghana Living Standards Survey round 7 (GLSS 7) reports that from a spatial perspective, about 11.3% of the population of Ghana live below the poverty line of $1.90 per day (Ghana Statistical Service, 2017).

Regional disparities in poverty are apparent, with Northern Ghana having the highest poverty rate, which dwindled from 2011 to 2017 to between 50% and 70%, while that of Southern Ghana has been around 20% and 30% (Ghana Statistical Service, 2017). The development of irrigated area has however, remained slow with less than 2% of the potential irrigable land being in use (Mendes et al., 2014; Namara et al., 2011). Irrigation by use of small reservoirs is the most common system. Most of the small-scale schemes are in the northern part of the country, especially in the Northern Region, Upper East Region and Upper West Region, being the driest areas, where the rainfall amounts to around 1,000 mm (40 in) per year with only one rainy season, which reaches its peak in the summer months, especially July and August (Bukari & Aabeyir, 2022).

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In the Upper West Region where the Nadowli-Kaleo District is located, the dry season occupies one part of the year, from November to mid-March, while the rainy season lasts for the remaining part (April to October) (Ghana Meteorological Agency, 2022). Irrigation is therefore essential for the enhancement of agricultural production. The nature of irrigation in the study district is characterized by a number of earth embankments constructed as dams and dugouts to create water reservoirs, especially for dry season farming. Portions of land in the flood plain areas of the dams are allocated by traditional authorities free of charge to native small-scale irrigation farmers. Vegetables and quite recently rice are the crops mainly cultivated under irrigation in the area. The vegetables include cabbage (Brassica oleraciavarcapitata), tomatoes (Lycopersicumesculentum), cow pea leaves (Viciaspp) and lettuce (Latuca sativa).

How these climatic conditions impact on livelihoods through irrigation is the focus of this study. Livelihoods comprise of assets, activities and access to both of these factors, which determines the means of living gained by households or individuals (Food and Agricultural Organization [FAO], 2015; Freeman, 2004). Households attempt to diversify their livelihood strategies by optimizing the use of their capabilities and assets. Households with well-diversified assets and livelihood strategies can cope better than those with a more limited asset based and few livelihood resources thus creating a veritable safety net for these households (Ayana, Megento & Kussa, 2022). Diversified sources could include a

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combination of salaries or wages obtained through employment, remittances, social grants, and even income or perhaps food generated through agricultural activity.

1.2 Problem Statement

Ghana has about 0.36-1.9 million hectares of potentially irrigable land area, and only 33,000 ha is under irrigated cultivation (International Food Policy and Research Institute [IFPRI], 2010). The Northern part of Ghana where the Nadowli-Kaleo District belongs, falls under the tropical continental climatic belt, with higher temperatures and a single maxima rainfall regime. Although since the 1960s, governments have embarked on various agricultural programs and projects, including the construction and rehabilitation of small dams and dugouts to provide reliable water supply for irrigation to mitigate the effects of aridity in this area and other parts of the country, the progress has not been far-reaching enough (GIDA, 2014). In other words, the effect of receding rainfall on crop cultivation remains a serious problem that most farmers still encounter year-round, despite improved technology, infrastructure and institutional support under the Government's policy to improve small-scale irrigation (MoFA, 2011; 2013).

Additionally, inputs like fertilizer and insecticides are also not easily accessible in terms of availability and highly inflated prices to farmers. In view of the single rainfall regime (between April and October) and the high incidence of rural poverty rate (between 70% and 50%) in the Northern part of Ghana (GSS, 2017),

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irrigation farming has been one of the coping strategies, and in the Upper West Region, about 154 small-scale irrigation schemes have been established (Kpieta et al., 2011).

Several studies have been conducted into the relevance of irrigation to livelihood improvement and also certain constraints militating against the realisation of the impacts of irrigation on livelihood. Empirically, one of such studies was conducted by Burney and Naylor (2012) in rural northern Benin, in which they examined the effects of solar-powered technology in small-scale irrigation schemes on poverty alleviation. But although the study looked at aspects of the nature of irrigation and the livelihood components, the specific focus on solar-powered technology makes it narrower in scope, while the choice of rural northern Benin as the study area generates a gap in the geographical scope, by raising more curiosity in the specific cases of other rural locations in other parts of Sub-Saharan Africa, such as rural northern Ghana. Another study was conducted by Obouret al. (2016), in which they explored the impacts of dams on local livelihoods, using the Bui Hydroelectric Project in Ghana as a case study. This study was however, too broader in scope as it failed to focus on irrigation as a means of livelihood, but rather emerged with a general recommendation for the improvement of agriculture in general. The statement that the study used case study and mixed research approached to collect data was also misleading, since it is specific tools of data collection that are used to collect data, and not research designs. The thematic and methodological gaps created by Obour et al. (2016),

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provide enough grounds for further studies to fill the niche. Owusu, Obour and Nkansah (2017), and Peprah (2015) also investigated into downstream effect of dams on livelihoods of river dependent communities in Kpong, and the reticulation scheme at Sankana respectively. But these studies failed to explore other alternative livelihood opportunities that could address the shortfall in small-scale irrigation farming, which further constitute an empirical gap for further studies.

Although these interventions, however, economic and social problems such as reduced agriculture productivity, soil degradation, and rural poverty continue to affect smallholder irrigation farmers in the Nadowli-Kaleo district, thus giving the irrigation schemes a negative impression (Dapilah et al.,2021).

This study therefore sought to assess the implications of irrigation schemes on the livelihood improvement of irrigation farmers in three selected communities in Nadowli Kaleo district namely Kaleo, Nanville and Sankana by addressing the gaps in mainstream literature on this subject.

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1.3 Research Questions, Objectives and Hypotheses

1.3.1 Research questions

The main research question is:

How does adopting irrigation impact agriculture productivity and income of smallholder farmers?

Specific research questions are:

a. What is the nature of smallholder irrigation farming in Nadowli-Kaleo?
b. How does irrigation farming affect livelihoods of irrigation farmers' households?
c. What challenges are small holder irrigation farmers facing?
d. What are the alternative ways of improving livelihoods of irrigation farmers' households?

1.3.2 Research objectives

The main objective was to ascertain the implications of irrigation farming on the livelihoods of small holder farmer households in Nadowli-Kaleo district.

The specific objectives are:

a. Examine the nature of smallholder irrigation farming in Nadowli-Kaleo
b. To assess how smallholder irrigation farming affects livelihoods of households in irrigation
c. To ascertain the challenges of small holder irrigation farming

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1.3.3 Research hypotheses

$H0_1$: There is no significant difference between irrigation farming and employment status of smallholder farmers

$H0_2$ There is no significant difference between irrigation farming and income levels of smallholder farmers

$H0_3$: There is no significant difference between irrigation farming and household food security of smallholder farmers

1.4 Significance of the study

This research will be relevant to the government, multilateral, bilateral and non-governmental organizations as it will provide insights to whether the provision of small scale irrigation is contributing to efforts aimed at improving the livelihood of small holder farmers. It will also inform stakeholders of the challenges that irrigation farmers face so as to design strategies and mechanisms to address them in order to prevent irrigation project failure and collapse.

In general, it is obvious that several studies have been conducted on small-scale irrigation schemes and the livelihood implications. But apart from the empirical, thematic and methodological gaps identified above, it has been found that no study has been conducted on the contribution of irrigation to livelihood improvement in the Nadowli-Kaleo District since the construction of the dams in the area several decades ago.

Practically, several policies and strategies have been implemented in Ghana to link irrigated agriculture to livelihoods. For examples the Ghana's irrigation policy and its associated strategy for implementation aim at promoting

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investments for intensified and diversified crop production in Ghana where there is clear comparative advantage (Ministry of Food and Agriculture, 2011). Others include the Planting for Food and Jobs and One Village-One–Dam flagship initiatives of the Ghana Government. However, there are no enough evidences of built capacities of agricultural institutions and the Nadowli-Kaleo District Assembly for the implementation of the specific provisions of the policy and other initiatives for the realization of their benefits in terms of improving livelihoods of small-scale irrigation farmers.

1.5 Scope of the Study

Geographically the study covers irrigation farmers in the Nadowli Kaleo District of the Upper West Region of Ghana. Thematically it is focused on the implications of small-scale irrigation farming on the livelihoods of households practicing it as an occupation.

1.6 Organization of Work

The study is organized into five chapters. Chapter one outlines the background of the study, problem of the statement, research questions and research objectives as well as the purpose of the study. Chapter two reviews relevant literature on irrigation to rural livelihoods. Chapter three of this study is focused on methodology of the study such as the population size, research design, and sample size as well as procedure for the collection of data. Chapter four consists of the presentation of data collected, analysis and discussion of the study's findings.

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Finally, chapter five presents the summaries of the findings, recommendations and suggestions for further studies.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter is the literature review section of the study and as such offers definitions of relevant terms, review of issues with respect to irrigation farming on the livelihoods of smallholder farmers. The section basically reviewed existing literature with the view of providing and adopting theories and relevant concepts important to the study. It captures a cross section of views and positions on the subject matter held by different scholars helping the ultimate reader to acknowledge the study against the framework of several existing knowledge and viewpoints. It further cross examines the conditions necessary for irrigation farming and the challenges facing smallholder of irrigation farmers in the Nadowli-Kaleo District of the Upper West Region.

2.2 Theoretical Foundations of the Study

2.2.1 Theory of planned behavior

The Theory of Planned Behavior (TPB) was originally known as the Theory of Reasoned Action in 1980, to predict an individual's intention to engage in a

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behavior at a specific time and place (Lamorte (2019). It was later revised and expanded by Fishbein and Ajzen (2000), to explain all the intended behaviors over which people have the ability to exert self-control. According to Lamorte (2019), the TPB states that behavioral achievement depends on both motivation (intention) and ability (behavioral control).

Behavioral intention refers to the motivational factors that influence a given behavior, where the stronger the intention to perform the behavior, the more likely the behavior will be performed. On the other hand, behavioral control refers to a person's perception of the ease or difficulty of performing the behavior of interest (Lamorte, 2019). This TPB has been applied in several fields in research, such as health seeking behavior, smoking and substance abuse.

Its major limitation is that it assumes individuals have acquired the opportunities and resources to be successful in performing the desired behavior, regardless of the intention. Despite this limitation, it was found to be relevant to this study because it gives a guide to the exploration of farmers establish linkages between the nature of climatic conditions, especially rainfall pattern or the seasons, availability of water resources for irrigation, and the behavioral intention to carry out irrigation farming with the aim of improving their livelihoods, as well as what constraining factors may pose control to their perceived intensions. The TPB therefore provides a guide for exploring and analyzing data to address research questions a, b, c, and d, which sought to enquire into the nature of irrigation

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farming in the study area, its effects on livelihoods, the challenges and alternative ways of improving livelihoods through small-scale irrigation.

2.2.2 Livelihood sustainability framework

The livelihoods framework has been developed as a tool to analyze the complexity of people's livelihood, particularly that of the poor irrespective of rural or urban setting. The tool for livelihood analysis sets out to conceptualize: how people operate within the vulnerability context that is shaped by different factors that includes; shifting seasonal opportunities and constraints, longer term trends and economic shocks e.g. prolonged draught, how these poor people draw on different types of livelihood assets or capitals in different combinations which are influenced by; the vulnerability context, a range of institutions and processes and finally how they use their asset base to develop a range of livelihoods strategies to achieve desired livelihood outcomes (De Stagé et al., 2002).Figure 2.1 shows a framework for micro policy analysis of rural livelihoods.

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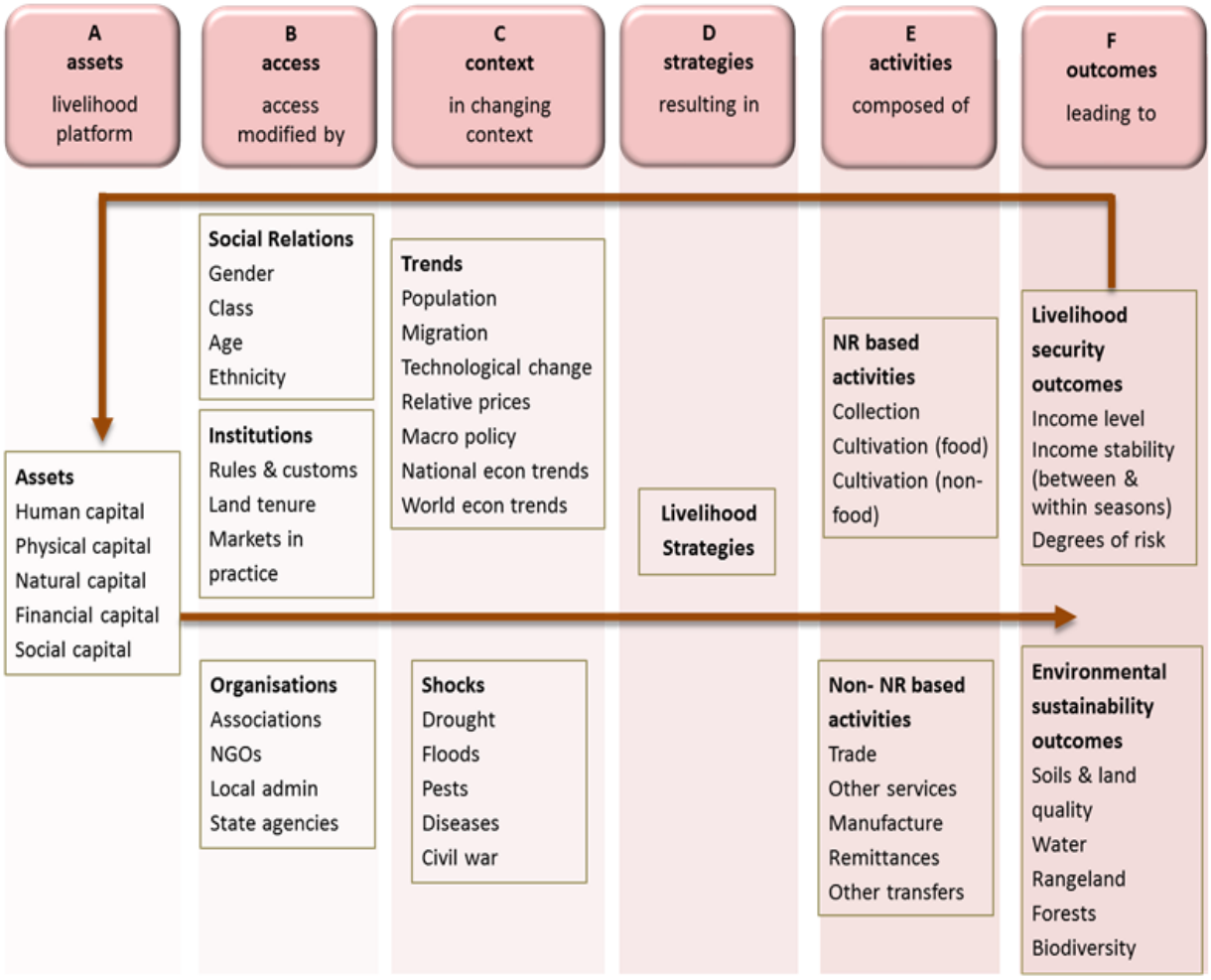

Figure 2.1: Framework for micro policy analysis of rural livelihoods
Source: Ellis (2000) p. 30.

As indicated in the framework, people operate in a context of susceptibility, surrounded by which they access some assets. Assets expand in weight and worth throughout the widespread of social, institutional and organizational environments (policies, institutions and processes). This context decisively shapes the livelihood strategies that are released to people in quest of their self-defined beneficial livelihood outcomes (Villholth, 2017). The elements of the framework include the following

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Livelihood assets

The livelihood framework is concerned mostly with people; it seeks to obtain an accurate and realistic understanding of people's strengths (Assets or Capitals). It is crucial to understand and analyze how people endeavour to convert these strengths into positive outcomes of their livelihoods. This livelihood approach is founded on the conviction that humans require a range of assets to achieve positive livelihood outcomes. Therefore, the livelihood framework identifies five major types of assets or capitals upon which livelihoods are built and developed, namely Natural capital, Physical capital, Social capital, Human capital, and Financial capital (Walters & Groninger, 2014).

Social capital emphasises the importance of connectedness for improving access to resources and assets (Walters & Groninger, 2014) and this is especially important in the more complex social milieu of the rural communities, whilst financial capital is a key factor behind the involvement of most households in petty trading which is often a hand to mouth affair because they have limited access to credit facilities (Wheeler et al., 2017). Human capital is essential as households depend on economic, social and psychological supports from their children and other dependents (Walters & Groninger, 2014).

Livelihood access

Social relations, institutions and organizations can determine access to assets and influence decision making processes. These have a direct impact upon whether

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people are able to achieve a feeling of inclusion as well as welfare. Since tradition is integrated in this part and they also count for other 'unexplained' differences in the 'way things are done' in different societies (Ellis, 2000). The importance of policies, institutions and processes cannot be overemphasized, because they function at all aspects, from the family unit to the global field, and in most spheres, commencing from the most confidential to the most unrestricted. They effectively determine access (to a variety of capital and its types, to livelihoods and its forms and to supervisory bodies and their sources of authority), conditions of substitution between diverse forms of capitals, and returns to any given livelihood strategy (DFID, 2019).

Livelihood context

Trends and shocks serves as important factors in livelihood strategies. Trends can cause a sudden change that can result in a possible wiping out of assets that are not protected, whereas trends can result in assets being eroded gradually if livelihoods are not able to adopt to change. The vulnerability context frames the external environment in which people exist as Wilson (2012) conceptualized vulnerability as a place-bounded rural phenomenon in terms of the lack of social, economic and environmental capital. Critical trends as well as seasonality and shocks, in excess of which persons have inadequate or no control, have a great influence on people's livelihoods and on the wider accessibility of assets.

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The trends and seasonality are not and must not always be considered as negative. The difference between risk and vulnerability is of crucial relevance for assessing causes of poverty. Risk is defined as the likelihood of occurrence of (external) shocks and stresses plus their prospective cruelty, whereas susceptibility and vulnerability is the measure of exposure to risk (hazard, shock) and uncertainty, and the capacity of households or persons to avoid, alleviate or cope with risk (DFID, 2019).

Livelihood strategies and activities

Livelihood strategies are directly dependent on asset status and policies, institutions and processes. Livelihood strategies comprise the range and combination of activities and choices that people make/undertake in order to achieve their livelihood objectives. This is understood as a dynamic procedure in which people combine activities to meet their various needs at different times. Different members of a household might live and work at diverse places, provisionally or permanently (DFID, 2019).

Strategies can be examined from the individual or from the household perspective, although there are challenges with considering the household as a unified decision-making unit pursuing a joint strategy with common goals. A collective household can possibly use a wider range of strategies compared to an individual acting alone.

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Livelihood outcomes

Livelihood outcomes are the achievements or outputs of livelihood strategies, such as extra revenue, augments and increases welfare, reduces susceptibility, improves food protection and a more sustainable use of natural resources (Villholth, 2013).

It is worth indicating that whereas better access to livelihood assets and the outcome of greater livelihood security are mostly important objectives in livelihood strategies, environmental sustainability may or may not be considered an objective. As a result, in livelihood framework the environmental sustainability is usually referred along with livelihood security as an outcome variable rather than as an objective.

Strengths and limitation of the SLF

The DFID's sustainable livelihoods framework (SLF) has a flexible design and opened to changes that make it adaptable to diverse contexts. The SLF has the capacity to serve as a diagnostic and analytical tool in order to identify development priorities and new activities prior to any development activity. Furthermore, the SLF might be used as a checklist or means of structuring ideas or can be applied in the form of a livelihood analysis to assess how development activities 'fit' in the living of the poor (Kolmair*et al*. 2020)

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In addition, the SLF does not contradict other current development approaches, it rather tries to combine and promote their capacity and strengths. This dwells on contribution and pays an extraordinary interest to gender specific or ecological issues. A livelihood investigation and analysis therefore involves a broad range of conventional methods and instruments, for example from Participatory Poverty Assessment (PPA), Participatory Rural Appraisal (PRA) and Good Governance Assessment techniques (Kolmairet al., 2020).

Accordingly, the Sustainable Livelihood Framework indicates a comprehensible and realistic view on how to reduce poverty and has generated (if used effectively) a good way of integrating the four pillars of development (economic, social, institutional and environmental).

However, some limitations within the SLF can be identified. A differentiated livelihood analysis needs time, monetary and human capital, say for the construction of irrigation dam. Growth and development programmes frequently lack these state of affairs. The claim of being holistic inevitably delivers a flood of information hardly possible to cope with. Additionally, by improving the livelihoods of a specific group, (say utilizing an irrigation dam), a negative effect or attitude may occur from other people, such as cattle headmen allowing their cattle to encroach irrigation farms. However, in view of the prolonged dry seasons in the true tropical continental climatic zone in which the Nadowli-Kaleo District falls, and its negative implications on rain-fed food crop farming, the LSF

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provides an analytical trajectory for explaining how small-scale irrigation farming sustains and improves the livelihoods of households engaged in the practice. This relevant for providing a theoretical lens for addressing research questions c and d.

2.3.1 Philosophical foundation of the research

This section on research philosophy dealt with the beliefs that guided the logical deduction of relationships between variables, concepts and causalities, for the establishment of truth or realities for the understanding of the outcomes of a study (Bukari, 2017). It focused on the essential epistemological positions and philosophical paradigms as discussed below.

Epistemology

Epistemology is the branch of philosophy that deals with the extent of reliability of claims to knowledge. Objective reality and subjective reality are the relevant epistemological positions discussed in the subsections that follow, as applied in this research.

Objective perception of reality

Objective reality was conceptualized by Ayn Rand in 1943, to explain the processes by which knowledge is acquired through what is perceived by the senses such as sight, touch, smell and taste, which can be followed by all members of a given society to measure what is truth. It constitutes the philosophical position of positivism (or measurability) about reality, and so related to quantitative aspect of the descriptive research design adopted for this

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study and explained later in the section on research design in this chapter. For example, aspects of the socio-economic background, participants of small-scale irrigation farming, their outputs and income levels were observed by sight and measured numerically. The aim of objectivism is to reduce researcher's bias. Its major limitation is that, human behaviour cannot be predicted with certainty through the application of natural laws (Bukari, 2017).

Subjective perception of reality

Subjective reality is an indirect perception of reality, compared to objectivism. This is because it explains knowledge as emanating from what is socially constructed or formed from the minds of people (Creswell, 2014). Subjectivism originated from "Descartes' methodic truth, which considers all laws and measurements as primarily resulting from subjective experiences" (Bukari, 2017: 124). The limitation of subjectivism is that it lacks control over the researcher's bias towards the measurement of reality. However, given the qualitative nature of explanatory research designs that build heavily on respondents' own explanation of what is reality about the phenomenon being investigated, subjectivism is still relevant in this study and other forms of qualitative research methodologies.

2.3.2 Philosophical paradigms and theories

The philosophical research paradigms and theories, which explain the thinking trajectories that shaped the research methods for promoting logical standards in this study, are presented below.

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Positivism

According to Macionis and Gerber (2010), positivism considers knowledge as emanating from direct experiences through the use of the senses, tested and interpreted through logical reasoning, rather than from metaphysical speculations and intuition. It's based on the view that whatever exists can be verified through experiments, observation, and mathematical/logical proof. According to Macionis and Gerber (2010), the epistemological position of positivism about reality is objectivism. Positivism was found to be contextually relevant to this study is that, those aspects of the research questions that deal with directly observable and measurable phenomena, such as those specified under the section on objective reality were ascertained by the use of quantitative approach and linked to the descriptive research design.

Phenomenology

Phenomenology is a philosophical theory, was applied in this study by finding answers to the same research questions addressed under the survey method, using qualitative instruments such as focus group discussions, observations and interviews. The phenomenological character of this approach reflected in how the research questions were addressed based on respondents' perceptions and interpretation of phenomena related to small-scale irrigation from the constructivist point of view, "'and then comparing findings to what has been objectively shaped for them as covered by the quantitative approach" (Bukari, 2017: 155).

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2.4 Conceptual Underpinnings of the Study

2.4.1 Concept of agriculture

By definition, agriculture is the comprehensive word used to describe ways in which crop plants and domestic animals sustain the global human population by providing food and other products. The word originates from the Latin "Agre" (field) and "Colo" (cultivate), which are merged to form Agriculture: land tillage (David &Doran, 2014). However, the term has emerged to comprise of cultivation, domestication, arboriculture, horticulture, vegeculture, pastoralism and transhumance.

Agriculture growth is the primary source of poverty reduction in most agriculture-based economies. Agriculture is diverse and full of contradictions. The sector accounts for a comparatively small share of global economy, but remains central to the lives of a great many to people. In 2012, of the World's 7.1 billion people, an estimated 1.3 billion (19%) were directly engaged in farming, but agriculture (including the relatively small hunting/fishing and forestry sectors) represented just 2.8% of overall income (World Bank 2012). However, in today's middle- and low-income countries, where most of the world's farmers are to be found, agriculture accounts for a much greater share of national income and employment.

Looking beyond direct employment, in 2010 about 2.6 billion people around the World depended on agriculture for their livelihoods, either as actively engaged

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workers or as dependents, while about half of the world's population lived in rural areas and, of these, about three-quarters were estimated to be living in agriculturally based households (Dittoh et al., 2013). Agriculture supplies much more than food for direct human consumption: it produces significant amounts of feed (for livestock), fuel (for transportation, energy production, including household kitchen fiber (for clothing), and, increasingly, agricultural biomass used to produce a host of industrial chemical and material products. In the specific case of Ghana, the agricultural sector employs about 40% of the economically active persons (ISSER, 2018). The understanding of agriculture as a concept in this study is necessary because irrigation is an aspect of agriculture, which deals with alternative ways of providing water to farms which would have been dry if such alternative means are not used.

2.4.2 Smallholder farming

The definition of Smallholder farmers varies across countries and regions since their categorization can depend on a variety of factors such as living standards, land ownership, agriculture activities, production scale, access to resources and share of family labour. According to the Food and Agriculture Organization (FAO) groupings, farms under 2 hectares are small (Mass Wolfenson, 2013).

Smallholder farmers are vibrant for transitioning to more sustainable forms of agriculture. Improving their participation in sustainable agricultural supply chains represents a significant opportunity that may lead to substantial benefits, like

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poverty reduction gender equity and a healthier environment. Thus, the expansion of smallholder farming can lead to a faster rate of poverty alleviation, by raising the incomes of rural cultivators and reducing food expenditure, and thus reduces income inequality (Huppe, 2015). As observed by Foster et al (2013), a rise in average household income by 2 percent leads to a fall in the poverty rates by about 4 percent on average. The 2008 World Development Report also observed that GDP growth originating in agriculture is about four times more effective in reducing poverty than GDP growth of other sectors (World Bank, 2018).

Various estimates have indicated that there have been positive, though marginal, changes in the poverty profiles of the studied country- Ghana, but not to the level needed to meet the MDG 1- Eradicate extreme poverty and hunger. Most of the household surveys conducted in the last decades showed that poverty is more prevalent among rural dwellers. Also, changes in poverty levels by employment across sectors indicate that change in poverty status among rural dwellers engaged in agriculture was higher than among rural populations engaged in other vocations. In addition, change in poverty among farmers and fishing folks in the rural sector was higher than change in poverty level among those engaged in other occupations in urban centers, except those engaged in paid employment and self-employment. The literature on the concept of smallholder farmer was relevant this study because the focus of the study is on small-scale irrigation farming. So the concept enabled this study to grasp an understanding of what small-scale farming is about, so as to know what variables to measure in order to establish a better

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meaning in line with what other scholars ever did, while filling the identified research niche.

2.4.3 Irrigation farming

The Ministry of Food and Agriculture (MOFA) of Ghana, which contributes to the promotion of small-scale irrigation (SSI), considers irrigation in the semi-arid areas of Ghana as a climate variability adaptation measure in response to the declining rainfall and increasing intermittent dry spells during the rainy season cropping period (MOFA, 2014). This study therefore conceptualises irrigation farming as an anthropogenic method of making farming possible through alternative means of supplying water to farmlands, other than the dependence on natural hydrological processes of supplying water to plants and crops.

The Food and Agriculture Organization (FOA) of the United Nations (2014) report on Irrigation Market Brief on Ghana observed that more than half of Ghana's land suitable for agricultural production is not being cultivated. The report further revealed that potential irrigable land in Ghana amounts to 1.9 million hectares. This potential, however, remains largely underdeveloped. Only 1.6 percent, or 31 million hectares, is under fully controlled irrigation- one of the lowest percentages in Africa. Again, results of studies by the SEND Foundation (2018) show that only 19.7 percent of smallholders have access to public irrigation programs, and 60 percent of these farmers use non-mechanized irrigation techniques. The understanding of the concept of irrigation farming from

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the literature reviewed in this study facilitated the right selection of study areas and sampling units or target respondents in order to get the right information to address the research questions, since the study is about irrigation.

2.4.4 Livelihoods

Livelihoods are about individuals, households and groups assets and capabilities available for making actionable decisions towards meeting various consumption and economic necessities while coping with uncertainties and responding to new opportunities (Torou et al 2013). The conception of livelihoods has gained wide recognition as a valuable means of understanding the factors that influence people's lives and well-being, particularly those of the poor in the developing world (Nkhoma, 2011). The concept is a contested subject with perspectives extending transversely the concern of its definition, chronology, measurement, explanation and normative judgement as well as its epistemological stance. In spite of this, it has been embraced by numerous development agencies, with the United Nations Development Program (UNDP) and Department for International Development (DFID) adopting it as an essential strategy for meeting the goals set out in its 1997 White Paper; "Eliminating World Poverty". Ever since the debate on what livelihoods are or how livelihoods are measured have taken centre stage in socio-economic research, Livelihood has several meanings and has been used synonymously or interchangeable with a sustainable livelihood.

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A livelihood system refers to the total combination of activities undertaken by a typical household to ensure a living (FAO, 2015). Whilst Grown and Sebstad (2014) use the concept of livelihood systems as the mix of individual and household endurance strategies, developed over a specified phase that seeks to organize available resources and opportunities.

A commonly adopted definition of a livelihood is that it "comprises the capabilities, assets (including both material and social resources) and activities essential for a way of livelihood" (Stirzaker & Pittock, 2014). This is argued from the Sustainable Livelihoods viewpoint that livelihoods are pursued within vulnerability contexts and structural processes that influence livelihood outcomes and these contexts and processes should be sustained. The research questions b and d of this study were interested in livelihoods of farmers, especially how irrigation farming influences livelihoods. As a result, the understanding of the concept of livelihood from the literature facilitated the identification of variables to measure to ascertain how irrigation farming was changing livelihoods of farmers in the study areas.

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2.5 Empirical Literature

2.5.1 The nature of smallholder irrigation farming

Irrigational farming as described is the application of water to soil for the purpose of supplying the moisture essential for plant growth. It plays a crucial role in enhancing crop yields and stabilizing production. It is vividly clear that, about 99% of the water absorbed by plants is lost by evaporation and transpiration from the plant surface. Thus, a crop‘s water requirement is equivalent to evapotranspiration desires. However, evapotranspiration desire mainly depends on climatic factors which can be measured through the use of meteorological information (FAO, 2020). A computerized program known as Cropwat is used by FAO (2020) to determine the water requirement of crops through the available climatic data. This is presented in Table 2.1, showing some selected crops and their water requirements.

However, the actual amount of water required needs to be adjusted to match the climatic changes. Conversely, the quality of water supplied is very vital for crops growth. Farming practices including, irrigation method, type of crop and agronomic practices heavily determines the quality of favorable irrigation water. To obtain a maximum yield, water must be applied to the crops before the soil moisture potential reaches a level at which the evapotranspiration rate is most likely to be reduced below its potential.

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Table 2.1: Water requirements of some selected crops

Crop	Water Requirements (mm/growing period)	Sensitivity to water supply (ky)	Water utilization efficiency for harvested yields, Ey,kg/m³ (%moisture)
Banana	1200-2200	High (1.2-1.35)	Plant crop: 2.5-4 Ratoon:3.5-6 Fruit (70%)
Beans	300-500	Medium-high (1.15)	Lush: 1.5-2.0 (80-90%) Dry: 0.3-0.6 (10%)
Cabbage	380-500	Medium-low (0.95)	12-20 Head (90-95%)
Cotton	700-1300	Medium-low (0.85)	0.4-0.6 Seed cotton (10%)
Citrus	900-1200	Low to medium-high (0.83-1.1)	2.5 fruit (85%, lime: 70%)
Groundnut	500-700	Low (0.7)	0.6-0.8 Unshelled dry nut (15%)
Maize	500-800	High (1.25)	0.8-1.6 Grain (10-13%)
Potato	500-700	Medium-high (1.1)	4.7 Fresh tuber (70-75%)
Rice	350-700	High	0.7-1.1 Paddy (15-20)
Sorghum	450-650	Medium-low (0.9)	0.6-1.0 Grain (12-15%)
Wheat	450-650	Medium high Spring: 1.15; winter:1.0)	0.8-1.0 Grain (12-15%)
Safflower	600-1200	Low (0.8)	0.2-0.5 Seed (8-10%)
Alfalfa	800-1600	Low to medium-high (0.7-1.1)	1.5-2.0 Hay (10-15%)

Source: FAO (1979)

In terms of dominant irrigated crops, the Food and Agriculture Organization Corporate Statistical Database [FAOSTAT] (2013) assert that rice and vegetables dominate the small irrigated crop sector, rice covering about 190000 hectares and vegetable covering 77000 hectares. They added that about 11% of rice production is irrigated with flood irrigation (20,000 hectares), and 50% of vegetable production is irrigated (40,000 hectares). However, much of this irrigation takes

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place on the same land. The irrigation used for commercial rice production is used for vegetable production as a second annual crop, while some vegetables under irrigation are double-cropped (FAOSTAT, 2013).

Another aspect of the nature of irrigation farming is the methods used. There are different methods available for farmers to irrigate their crops. Methods ranging from watering individual plants by means of watering cans to highly automated irrigation through a center pivot system. Irrigational methods can be classed in to five groups: flood irrigation is where water is applied over the entire field to infiltrate into the soil e.g. contour flooding, wild flooding and others; sprinkler irrigation is where the water is applied using a machine to reach the soil very much like rain e.g. travelling sprinkler, spray guns and others. The rate at which water is applied is adjusted to avoid water pending on the surface; in furrow irrigation the farmer applies the water between ridges where the plant roots are concentrated through capillary actions, e.g. Contour furrows, corrugations, and others; in localized irrigation the farmer applies water around every plant. The application rate is accustomed to match evapotranspiration requirements in order to minimize percolation losses, e.g. micro-sprinklers, drip irrigation, bubblers and others; sub-irrigation is where the root zone is supplied with water to wet the root zone through capillary rise. Buried pipes and deep surface canals are the most common examples of sub-irrigation. Table 2.2 presents some basic features of some selected irrigation systems as reported by Doneen and Westcot (1988).

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Table 2.2: Methods of Irrigation

Irrigation method	Topography	Crops	Remarks
Widely spread borders	Land slope capable of being graded to <1% slope and preferably 0.2%	Alfalfa and other deep tooted close-growing crops and orchards	The most required surface method for irrigating close-growing crops where topographical conditions are favorable. Cross slops is permissible when confined to differences in elevation between boarder strips of 6-9 cm. water application efficiency 45-60%.
Graded contour furrows	Variable land slopes of 2-25% but preferably less	Row crops and fruit	Especially adapted to row crops on steep land, though hazardous due to possible erosion from heavily rainfall. Unsuitable for rodent-infested fields or soils that crack excessively. Actual grade in the direction of irrigation 0.5-1.5%. No grading required beyond filling gullies and removal of abrupt ridges. Water application efficiency 50-65%.
Rectangular checks (levees)	Land slopes capable of being graded so single or multiple tree basins will be leveled within 6 cm	Orchard	Especially adapted to soils with either a relatively high or low water intake rate. May require considerable grading. Water application efficiency 40-60%.
Sprinkler	Undulating 1->35% slope	All crops	High operation and maintenance costs. Good for very sandy land areas of high production and good markets. Good method where power costs are low. May be the only practical method in areas of steep or rough topography. Good for high rainfall areas where only a small supplementary water supply is required. Water application efficiency 60-70%.
Sub-Irrigation	Smooth-flat	Shallow rooted crops such as potatoes	Water table is required, very permeable subsoil conditions and precise leaving. Very few areas adapted to this method. Water application efficiency 50-70%.
Localized (drip, trickle, etc)	A0ny topographic condition suitable for row crop farming	Row crops of fruit	Perforated pipe on the soil surface drips water at base of individual vegetable plants or around fruit trees. Water application efficiency 75-85%.

Doneen and Westcot (1988)

Other conditions necessary for irrigation farming include leaching and drainage. Leaching forms one of the conditions necessary for irrigational farming. Irrigational farming requires an amount of extra water to percolate through the

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root zone so as to remove accumulated salts resulting from evapotranspiration from the original irrigation water. The process involved in displacing the salts from the root zone is termed as leaching and that excess water used to mobilize the excess salt is described as the leaching fraction (LF) (Nkhoma, 2011).

The term drainage is described as the removal of excess water from the soil surface and beneath in order to allow optimum growth of plants (Nkhoma, 2011). The removal of excess water from the surface is described as surface drainage while the removal of excess water from beneath the surface is described as sub-surface drainage. Drainage is very important in areas like semi-arid and arid areas to avoid secondary salinization. The water level in these areas will rise with irrigation when the natural internal drainage of soil is not adequate. When the water level is within a few meters of the soil surface, capillary rise of saline groundwater will transport salts to the soil surface. Water evaporates at the surface leaving the salts behind. If the process is not attended to, then salt will continue to accumulate and hence soil salinization. However, drainage system is required in such areas to control the rise of the water level, hence salinization is avoided.

In Ghana, more than half of the country's land suitable for agriculture production is not cultivated, and less than 1.6% of land is suitable for irrigational farming has been developed. The country has a water resource of almost 5,500 cubic meters of

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water per inhabitant as compared to that of 2,251 for Nigeria, 2,930 for Togo and 3,815 for Benin (Zakaria et. al., 2019).

The Agriculture sector in Ghana is dominated by small scale farms, approximately about 3 million small holder farmers, with an average farm size between 0.5 hectares and 2 hectares, presently produce about 95% of the country`s food crops (Ghana Irrigation Report, 2014). Small holder irrigational farmers largely depend on rain-fed through traditional subsistence approaches, particularly in the drought and flood prone Northern regions. However, it exposes farmers to significant risk when seasonal changes and droughts occur. With abundant cultivable land and sufficient water resources, the country offers ample scope for growth in agricultural production through irrigation development. Yet very scanty potential irrigable land is developed. The performance and productivity of existing irrigation schemes particularly, publicly developed ones, are generally low. The country`s vast available land, good soil, much water supply, favorable climatic condition offers a significant growth potential to irrigational commercial farmers and new irrigational technological advancement.

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2.5.2 Effects of smallholder irrigation farming on livelihoods

Agriculture provides livelihoods for millions of people in Ghana and Africa generally by offering work and food. In the specific case of Ghana, the agricultural sector employs about 40% of the economically active persons (ISSER, 2018). The livelihoods of many of these people are going through stress

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because of limited access to water that militates against agricultural productivity. Xie*et al.* (2014) noted that irrigation has therefore been identified as a promising remedy to boost levels of agricultural productivity. The situation is further exacerbated by inadequate investments in irrigation infrastructure, many farmers still relying heavily on rain-fed agriculture for survival. The Food and Agriculture Organization (FAO) of the United Nations (2014) report on Irrigation Market Brief on Ghana observed that more than half of Ghana's land suitable for agricultural production is not being cultivated. The report further revealed that potential irrigable land in Ghana amounts to 1.9 million hectares.

This potential, however, remains largely undeveloped. Only 1.6 percent, or 31,000 hectares, is under fully controlled irrigation, one of the lowest percentages in Africa. Again, the results of studies by the SEND Foundation (2018) show that only 19.7 percent of smallholders have access to public irrigation programs, and 60 percent of these farmers use non-mechanized irrigation techniques. The Ministry of Food and Agriculture (MoFA) of Ghana promotes small-scale irrigation (SSI) as a climate variability adaptation measure in response to the declining rainfall and increasing intermittent dry spells during the rainy season cropping period (MOFA, 2014).

This necessitated the government's One Village, One Dam (1V1D) initiative of the current government of the Republic of Ghana. Early efforts to meet the new challenges of agricultural development in Ghana include the Ghana Commercial

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Agriculture Project (GCAP) that was to help the Ministry of Food and Agriculture (MoFA) to provide irrigation facilities as well as train Water Users' Associations to enable them make judicious and efficient use of water resources (ISSER, 2018). There are large and medium reservoirs for public sector managed irrigation schemes at Libga, Vea, Golinga, Bontanga and Tono in northern Ghana with storage capacities ranging from 5.9 to 93 Mm3. Again, there are more than 500 small reservoirs and over 6,280 borehole's managed by communities and smallholder farmers in northern Ghana (Johnston and McCartney, 2013; GIDA, 2011). Water is also stored on-farm in ponds and wetlands (McCartney et al., 2013) for agricultural production purposes. Molden (2007) and Namara*et al.* (2011) both revealed shallow groundwater as the preferred water source for farmers' in northern Ghana. Also, permanent shallow wells are widespread in several communities (Lampte*yet al*., 2010). Small reservoirs and dugouts are in high demand because they support multiple livelihood strategies, including irrigation, livestock production, fisheries and brick fabrication (Namara et al., 2011).

Earlier studies have also shown a positive relation between access to irrigation, increased income and food security (Hussain, 2007; Shah and Singh, 2004; Huang et al., 2005, Gebregziabher et al., 2009). Again, a study by researchers from the International Food Policy Research Institute (IFPRI) (2015) shows that government expenditure on irrigation has a modest impact on economic growth

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and poverty reduction and that returns on investment in irrigation have been small.

In the specific case of Ghana, the prevailing weather conditions in the country, particularly the northern parts are such that the provision of irrigation technologies is critical for sustainable agricultural production, job and wealth creation for development. It is against this background that the government of Ghana initiated the Northern Rural Growth Programme (NRGP) and the Ghana Social Opportunity Project (GSOP) to invest in the rehabilitation of three different irrigation technologies across northern Ghana. These were small reservoirs for water storage and river based water-lifting technologies, specifically petrol/diesel powered water pumps for individual farmers and electricity powered pumps for groups of farmers. It is believed that these investments will translate to improvements in agricultural production, which is the surest way to fighting endemic poverty and inequality in northern Ghana, Ghana and Africa generally.

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Specifically, investments in these irrigation technologies are expected to maximize water usage for improved agricultural production likely to translate to improved livelihoods of the people who depend on agriculture for survival. These irrigation technologies are expected to encourage farmers; especially women and youth go into all year-round crop production for jobs and wealth creation. This is important for the transformation of Africa's agriculture that urgently requires changes in production techniques and methods including the introduction

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irrigation technologies. It must be noted that changes do not always bring positive benefits to the farmer. So, each change or technology must be analyzed and measured against the prevailing situation. This paper therefore aimed to determine if the investment in each technology is viable per given quantitative financial and economic criteria. Thus, the paper is financial and economic analyses of gravity flow small reservoirs as well as fuel and electricity powered motor pumps for irrigation in Africa using northern Ghana as a case.

2.5.3 Challenges of small holder irrigation farming and ways of mitigating the setbacks

Irrigational farming in Ghana is one of the major sources of finance and food for the country. An effective irrigational practice has over the years provided employment for the country and as a source of food. Irrigation farming among small holder farmers is hindered by numerous systematic and market restrictions. The systematic restrictions include infrastructure, trade duties, taxation, availability of labour, land tenure, access to water. On the other hand, the market restrictions include, lack of knowledge, inadequate finance, and ineffective supply chains (Lamptey et al, 2010). Below are some expatiated challenges of irrigation in Ghana

Irrigation infrastructure

One of the major restrictions of small holder farmers in irrigational practices is the absence of irrigational infrastructure and equipment in the country. About

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19.7% of smallholder farmers in Ghana have access to public irrigation projects and programs and an approximately, 60% of these farmers practice non mechanized irrigation methods (SEND Foundation, 2018).

Namara et al. (2011), added that governments have been deficient to provide and maintain a public irrigation infrastructure. They added that, irrigation service fees have not been enough to cover for the cost of maintenance, hence weak infrastructure. It also affected the ability of some public irrigational projects to fully develop an irrigable land (Namara et.al. 2011).

Inadequate planning and faulty designs have intensified the restrictions in infrastructure and equipment in the irrigation of Ghana. Despite variations in soils, topography, crops and farming skills, yet irrigational designs are mostly standardized. The numerous functions of water conveying systems (like domestic use, livestock watering, fishing and crop production) are not mostly reflected (Namara et.al. 2011). The sustainability of some irrigation can also be affected by siltation of reservoirs, canals and flooding.

Land tenure and availability for irrigation farming

Availability of land is one of the challenges faced by small holder farmers in irrigational farming. In Ghana, almost 80% of lands are possessed by the communities entrusted by the chiefs (SEND Foundation, 2018). Accessing such lands for farming is a major challenge for small holder farmers in the country.

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The ability of the Government to obtain the land for commercial irrigation purpose is a controversial issue and time consuming (SEND Foundation, 2008).

In addition, there is not enough available land in the areas of intensive ground water particularly in the coastal areas where most farms are sited near the town, hence a scanty room for irrigational expansion (Namara et.al. 2011). They added that, in the northern part of the country, where there is vast land yet faced with the lack of irrigable area. Making the ability of smallholder farmers to expand their irrigational farms is a challenge (Ghana Irrigation Report, 2014). In most instances, farmers cannot make a living from irrigation; hence they view it as a complement to other livelihood approaches.

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Roads

Another unthinkable challenge of small holder irrigation farmers is the access to good roads. In comparing Ghana with many countries in southern Africa, Ghana has good quality trunk roads and highways, yet lack of feeder roads is a barrier to develop areas of potential irrigable lands, unless the sites are near to main roads. Hence many smallholder irrigational investors are forced to limit their activities to areas that are near to main roads. Hence, more pressure on these lands while other lands remain unused (Ghana Irrigation Report, 2014).

Access to finance

Easy access to credit is one of the major hindrances to the development and advancement of the irrigational sector of Ghana, particularly small holder farmers.

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Many small holder farmers lack the requirements to access credits from the Banks and other finance houses, hence they seek to obtain small amount of finance through friends and family members, which is not enough to help acquire all the required inputs (Namara et.al. 2011). In addition, the high interest rate margin charged by the banks is a factor restricting farmer access to credits.

Access to Inputs and services

Among irrigational farming in Ghana, one of the key pressing concerns is the limited availability of inputs and the high costs of procurement. The lack of efficient well drilling and water lifting is a hindrance for the development of ground water irrigation. Most irrigation suppliers are based in Accra and have only recently started to expand their operations to cover the northern part of the country. Irrigational equipment is often not sufficient to farmers in both quality and quantity required. Conversely, if farmers have access to equipment, they may not have the knowledge and experience to operate them.

In addition, land preparation is another factor affecting the development of irrigation in Ghana. The availability and maintenance of irrigational farm machines is not widespread in Ghana. Irrigational farmers who want to use power tillers, sowing machines, tractors and others have to hire these machines from government agencies and private bodies. However, machines that are publicly owned are also faced with availability and maintenance challenge like the case of Ghana Irrigation Development Authority (GIDA). Adding to this, the Ghana

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Irrigation Report, (2014) revealed that extension services in the irrigation sector are inadequate, and extension personnel are often not familiar with information of emerging irrigational systems.

However, irrigational offers a great contribution towards the development of the country, hence strategies need to be created and implemented in order to bridge the gap in the drawbacks. As indicated by the Ghana Irrigation Report (2014), the Government has to step in by making irrigational projects and programs available to all small holder irrigational farmers. This will guide small holder farmers to advance their activities and encourage potential small holder farmers. Namara et.al. (2011) stressed that, government can effectively implement programs and policies by avoiding favoritism and corruption in granting access to the project as well as provide small holder farmers with well-trained extension services to help spread the knowledge of a particular project to the farmers in order to boost their knowledge.

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As suggested by Namara et.al. (2011), Government should impose interest charge restrictions on banks and to encourage the banks to extend duration for payment of credits from small holder irrigation farmers to enable them have access to enough credit in order to expand their activities. On the other hand, Government should serve encourage its agents (GIDA, SEEDPAG, SADA,MOFA and others) to serve as guarantors for small holder farmers through a careful review of the farmer's potential and the amount of credit required.

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As suggested by the Ghana Irrigation Report (2014), the government can encourage small holder irrigation farming by extending the main roads to link up with potential irrigable areas to enable small holders to have easy access to transportation. This will help avoid smallholder irrigational investors, restricting their activities to areas that are near to main roads.

The government and other bodies can encourage small holder irrigation farming through seminars, conferences, lectures and others for small holder irrigational farmers in order to train them on the use of some machinery (Namara et.al. (2011). They also advised that, farmers should avoid the over use of a particular land in order to avoid loss of fertility of the land but rather adapt the practice of crop rotation, shifting cultivation and other practices to enrich the soil fertility.

2.5.4 Irrigation in Ghana as an alternative to livelihood improvement

One of the major steps to identify and strategies on how to make irrigation an alternative livelihood improvement option in Ghana was by the development and adoption of the National Irrigation Policy, Strategies and Regulatory Measures. This has been reviewed as below.

National Irrigation policy

Realizing that Ghana is among the agrarian economies depending on agricultural production as basis for industrial development, and which is most likely to fail if irrigation is not part of the national development plan, a policy was developed to for the irrigation sector of the country. The Government of Ghana, through the

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Ministry of Food and Agriculture (MOFA) and the Ghana Irrigation Development Authority (GIDA), in collaboration with the Food and Agricultural Organization (FAO) of the United Nations, embarked on stakeholder consultation for the development and adoption of a comprehensive document as the National Irrigation Policy, Strategies and Regulatory Measures, published in 2011 (MOFA, 2011). The policy focused on addressing the problems, constraints and opportunities, which encapsulate the informal, formal and commercial irrigation subsectors. Below is the goal, core objectives or thrusts, targets, and beneficiaries of the policy, as extracted from MOFA (2011: 1):

Irrigation Policy Goal

Promote sustainable growth and enhanced performance of irrigation in contributing fully to the goals of the Ghanaian agriculture sector.

Policy objectives

Thrust A) Performance and growth: to realize the productive capacity of existing assets and respond to new demands for irrigated production through a mix of well-coordinated public and private initiatives;

Thrust B) Socio-economic inclusion: to remove constraints to a balanced socio-economic engagement with land and water resources;

Thrust C) Responsible production: raise the environmental performance of all types of irrigation and related agricultural practice; and

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Thrust D) Enhanced services: extend cost-effective, demand driven irrigation services to public and private irrigators.

Policy Targets: National food security; intensified and diversified production of agricultural commodities; increased livelihood options; optimum natural resource use; reduced negative environmental impacts; expanded investment space for irrigated production.

Policy Beneficiaries: The Ghanaian economy as a whole. All existing and potential irrigators and related farmer and farmer-based organizations, including private sector service providers.

A look at the goal and objectives of the national irrigation policy as stated above shows that the aspects of sustainability, growth, social inclusion and responsible production are threads that run through all the objectives of the current study. Also, the policy and beneficiary targets also apply to the research area of this study. Accordingly, efforts have been made to investigate the practical implications of the policy context on smallholder irrigation in the Nadowli-Kaleo District and how it impacts on livelihoods.

One village- one- dam programme

In 2017, the Government of Ghana introduced the 'One Village, One Dam' programme to construct dams in some villages in northern Ghana. The aim was to make irrigation accessible to small-scale farmers (Ghana News Agency [GNA]

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(2021). According to the Minister of State for Agriculture, Dr. Nura Gyiele, the Government promised 560 small dams, out of which 437 were under various stages of completion. Dr. Gyiele added that the programme included small earth dams and large-scale dams for water storage, livestock rearing and irrigation for crop production (Mensah, 2020).

Although the programme has a very good prospect of promoting small-scale irrigation and livestock rearing, Sore (2021), reported that the Peasant Farmers Association of Ghana who recently went on a tour to inspect the dams in the Upper East Region, says that farmers could not use the dams for any other purposes, except serving as source of drinking water for animals, because the dams are too shallow and easily dry out after the rainy season.

These features of the dams under the programme were the reasons why Bukari and Aabeyir (2019), described them as dug-outs, because majority of the dams dry up immediately after the rainy season by November, especially in villages of the Upper East Region of Ghana. Despite their intended purposes for villages, the communities studied in this research did not benefit from the programme. As a result, their effects on livelihoods could not be assessed.

The state of irrigation in Ghana

Presently, productivity of development farm land in the country is generally low and variable due to reliance on rain, particularly in the drought and flood prone Northern regions. According to Namara et.al. (2011) the abundant cultivable land

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and sufficient water resources, Ghana offers ample scope for growth in agricultural production through irrigation development. Yet as stated above, very little potential irrigable land is developed. The performance and productivity of existing irrigation schemes, particularly those that were publicly developed are generally low.

Irrigation has emerged to be central to the intensification strategy. Records date irrigation's beginnings in the country to about a century ago, but serious irrigation efforts date to the past fifty years. Between its inception in the 1960s and the year 1980, approximately 19,000 ha of irrigated land had been developed. By 2007 the area in irrigation had expanded to 33,800 ha.

The Ghana Irrigation Report (2014) asserts that irrigation systems observed in Ghana may be classified into two types: conventional systems, which are mainly initiated and developed by the Ghanaian government or various non-governmental organizations (NGOs), and emerging systems, which are initiated and developed by private entrepreneurs and farmers. Little is officially known about emerging systems, but they are expanding at a rapid rate, mainly fueled by access to relatively affordable pumping technologies and to export markets for horticultural crops. Table 2.3 presents details of the distribution of public irrigation schemes in some districts in Ghana.

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Table 2.3: Public Irrigation Districts

No	District	Area of developed land (ha)	Area of irrigated land (ha)	Irrigation Type	Target crop	Remarks
1.	Ashaiman	155	56	Gravity-type	Rice and vegetables	
2.	Dawhenya	200	150	Gravity & pump-type	Rice	
3.	Kpong	2,786	616	Gravity-type	Rice and vegetables	
4.	Weija	220	0	Pump-type		Abandoned 2003 Rehabilitation
5.	Afife	880	880	Gravity-type	Rice	
6.	Aveyme	60	0	Gravity & pump-type	Rice	Abandoned 1998 Rehabilitation
7.	KpandoTorkor	40	6	Pump-type	Vegetables	
8.	Mankessim	17	17	Pump-type	Vegetables	
9.	Okyereko	81	42	Gravity & pump-type	Rice	
10.	Subinja	60	6	Pump-type	Vegetables	
11.	Tanoso	64	15	Pump-type	Vegetables	
12.	Sata	34	24	Gravity-type	Vegetables	
13.	Akumadan	65	0	Pump-type	Vegetables	Abandoned Rehabilitation
14.	Anum Valley	89	0	Gravity & pump-type	Rice	Abandoned Rehabilitation
15.	Amate	101	0	Pump-type	Rice	Irrig Abandoned
16.	Dedeso	20	8	Pump-type	Vegetables	
17.	Kikam	27	0	Gravity & pump-type	Rice	Irrig Abandoned
18.	Bontanga	450	390	Gravity-type	Rice and vegetables	
19.	Gollinga	40	16	Gravity-type	Rice and vegetables	
20.	Liboa	16	16	Gravity-type	Rice and vegetables	
21.	Tono	2,490	2,450	Gravity-type	Rice and vegetables	
22.	Vea	850	500	Gravity-type	Rice and vegetables	
	Total	8,745	5,192			

Source: Miyoshi and Nagoyo 2006

Due to the effects of dwindling rainfall patterns on surface water sources for irrigation, agricultural use of groundwater, once mainly in domestic use, is rising due to access to pumping technologies. The Ghana Irrigation Report (2014)

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reveals that groundwater irrigation provides potential employment opportunities, particularly during the long dry season in the Northern Savannah zones of Ghana. It is also already one of the major livelihood strategies in the coastal zones of Volta region, particularly for those with access to electricity. However, full realization of the economic potential of groundwater faces numerous challenges including absence of explicit policy support, lack of access to fordable drilling technology, and cost of energy for abstracting water. Rice yields and profitability are better under private systems as compared to public systems. Vegetable cultivation is generally profitable under all typologies of irrigation system, except under the communal borehole system, which exhibits negative gross margins.

Irrigation development in Ghana has followed the global irrigation investment pattern, with a peak in 1970. However, the scale of overall development has remained low. Of the total 6.9 million ha of cultivable area in 2007, there were only 33,800 ha of irrigation land. This represents less than 0.5 percent of the total area. Of the gross estimated 1.9 million ha of potentially irrigable area, less than 2 percent has been developed.

Currently, public irrigation systems play a significant role in the overall agricultural economy of Ghana despite substantial efforts to develop the sector since 1950s. The cost of development (and also of rehabilitation) per unit area in use or per unit volume of water supplied is higher than the figures for comparable developing countries (incocencio et al. 2007). Capacity underutilization is a major

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problem in many existing irrigation facilities. The potential areas that can be developed in each of the public irrigation schemes are much higher than the developed or equipped areas, in addition, in any given year, only a fraction of the developed or equipped area is actually cultivated. Rehabilitation of many of the irrigation schemes is long overdue. Unfortunately, the quality of the implemented rehabilitation project is also questionable, as some schemes still suffer from structural defects despite repeated rehabilitation work.

The policy and practical contexts of irrigation in Ghana reveal gaps between aims and outcomes. This therefore calls for the need for cross-sectional studies with specific rural communities to ascertain the extent to which small-scale irrigation is contributing to the livelihoods of farmers.

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2.6 Conceptual Framework

According to Bukari (2017: 84) “The conceptual framework describes the researcher’s position regarding how the interrelated construct of ideas, concepts and variables derived from the reviewed theories and empirical evidences are operational, in order to address the identified research niche”. This section therefore describes the conceptual framework developed and used as clutches that enabled the researcher walk through the research process. The framework is built around the research objectives, theories, conceptual and empirical underpinnings of this study, as well as the variables that were measured. It takes inspirations

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from Nurgusse (2013) and Ziba's (2015) conceptualizations of livelihood objectives. Figure 2.2 presents the conceptual framework of this study.

The extreme left side of Figure 2.2 begins with a theme on nature of small-scale irrigation farming. This corresponds with the first research objective of this study and underlined by the motivation tenet of the Theory of Planned Behaviour, because it is some prevailing conditions, such as the nature of aridity in an area that generate intentions about which method of farming, especially sources of water (whether rain fed or irrigation) that is to be used (Lamorte, 2019). The operational context of the theme also draws inspiration from the livelihood sustainability framework. In other words, following the conceptualization by Ziba (2015) in the livelihood sustainability framework, that it serves as a tool for livelihood analysis with a focus on people's response to vulnerability contexts, shaped by different factors such as climatic and economic constraints and opportunities, the framework in Figure 2.2 directs this study to investigate into the socio-economic characteristics of participants of small-scale irrigation farming and the conditions (e.g. water availability/climatic conditions) that necessitate irrigation farming; the size of irrigated lands, crops cultivated, water sources and technology used; and the season and duration of irrigation farming.

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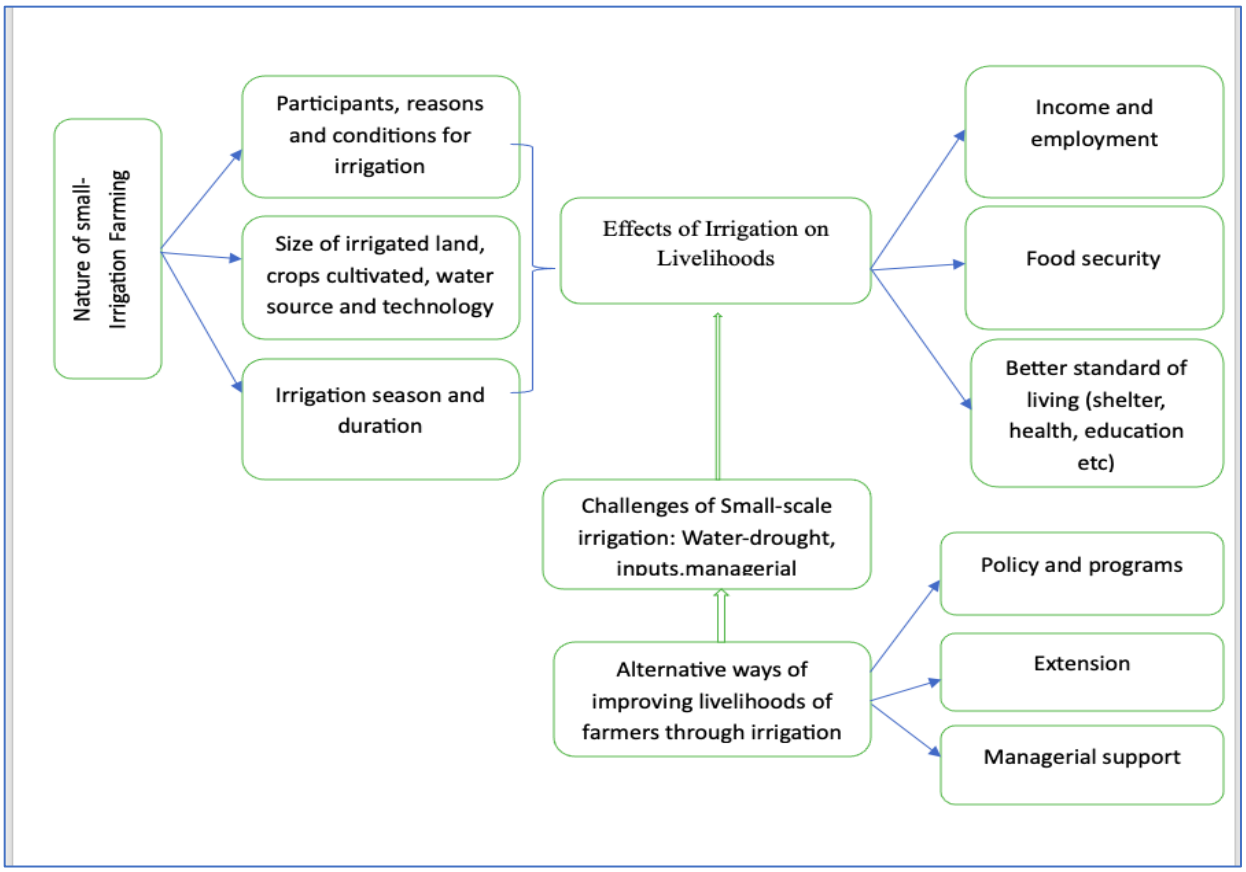

Fig 2.2 CONCEPTUAL FRAMEWORK

Source: Modified from Nurgusse, (2013); Ziba, (2015).

In line with the second objective, the next theme to the right of the first in Figure 2.2 is about the effects of irrigation on livelihoods of farmers. It also draws inspiration from the motivation tenet of the TPB and the tenet of livelihood outcomes of the Livelihood Sustainability Framework (LSF) (Kolmaire et al., 2018). In other words, small-scale irrigation farming involves a set of strategies, identified as livelihood strategies in the LSF. Accordingly, Figure 2.2 dictates inquiries into the outcomes or effects of such strategies through small-scale

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irrigation farming, and how these lead to opportunities to employment and income, food security and better standard of living (Xie et al., 2014).

Livelihood outcomes, as conceptualized by the LSF could either meet expectations of irrigation farmers or otherwise. This therefore calls for the need to explore some challenges in small-scale irrigation farming which could affect farmers' expectations. Below the second theme in Figure 2.2 is the third theme on challenges of small-scale irrigation, which is linked to the third objective of the study. Thus, despite the potential of irrigation farming to contribute positively to farmers' livelihoods, Figure 2.2 directs this study to investigate how water availability and the effects of drought, inputs, managerial and other constraints could impact on effects of irrigation on farmers' livelihoods as challenges (Lamptey et al, 2010).

Finally, the last theme of the conceptual framework in Figure 2.2 corresponds with the fourth and final objective of this study, which is about alternative ways of improving the livelihoods of farmers through small-scale irrigation. In this regard, Figure 2.2 suggests exploration of policy and programmes on irrigation, extension and managerial support could serve as alternative ways to improve farmers' livelihoods through irrigation. Such an exploration could expose how the livelihood assets, livelihood access and livelihood contexts of the LSF (Wilson, 2012), have practical relevance in policy and programme influences on the irrigation sector to improve farmers' livelihoods.

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The conceptual framework was relevant to this study because it establishes the links between the theoretical and conceptual bases of the study and generated the variables to be measured under the thematic areas related to the research objectives, which are indicated in bold in Figure 2.2. For instance, the nature of irrigation farming for objective 1, depicts variables such participants, type of crops, land size, type of technology, etc. in Figure 2.2. These provided a guide to the type of tools of data collection, the nature of questions to be asked, the selection of respondents, the research design and approach for each objective (whether quantitative or qualitative or mixed).

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CHAPTER THREE

METHODOLOGY

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3.0 Introduction

This chapter on research methodology was to present a systematic description of the methods used to achieve the objectives of the study. It begins with a discussion of the profile of the study area, followed by the research design and philosophical underpinnings, research approach, sampling design, methods of data collection (quantitative and qualitative), data analysis and ethical considerations.

3.1 Profile of the Study Area

3.1.1 Location and size

Nadowli-Kaleo District is one of the eleven districts located in the Upper West region of Ghana and was carved out of the then Nadowli District in June, 2012 under Legislative Instrument (L.I) 2101. With Nadowli as the administrative capital, the district is centrally located in the Upper West region and lies approximately between longitude 3’ 10’ to 2’10’ West and latitude 11’ 30’ to 10’ 20’ North. The district shares boundaries with the Wa Municipal to the south, Burkina Faso to the west, to the north is Jirapa District and to the east is Daffiama-Bussie-Issa District. The Nadowli-Kaleo District covers a territorial area of 1,132.02 km^2. From north to south, the district extends from the Dapuori

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Bridge (approximately 12km from Jirapa) located on the main Wa-Jirapa-Hamile road to the Billi Bridge (4km from Wa). It also extends from Daffiama to Black Volta as the east and west borders respectively.

Nadowli is the District Capital, which is about 41.0 km from Wa, the Regional capital. It lies between latitude 10.8' 28' and 9.8' 18' north and longitude 2.7' 10' and 1.9'10' west. The location of the District promotes international trade between the district and neighbouring Burkina Faso (Ghana Statistical Service, 2014).

The topography of the district is low lying and undulating at altitudes ranging between 150m-300m above sea level though some parts average 600m. There are few rivers and streams with seasonal droughts which prevent dry season farming resulting in low crop output levels and food insecurity. However, the seasonal rainfall, few perennial water bodies and groundwater resources support small reservoir-based communal irrigation systems. The district has a mean annual temperature of 32°C and a mean monthly temperature ranging from 36°C in March to 27°C in August.

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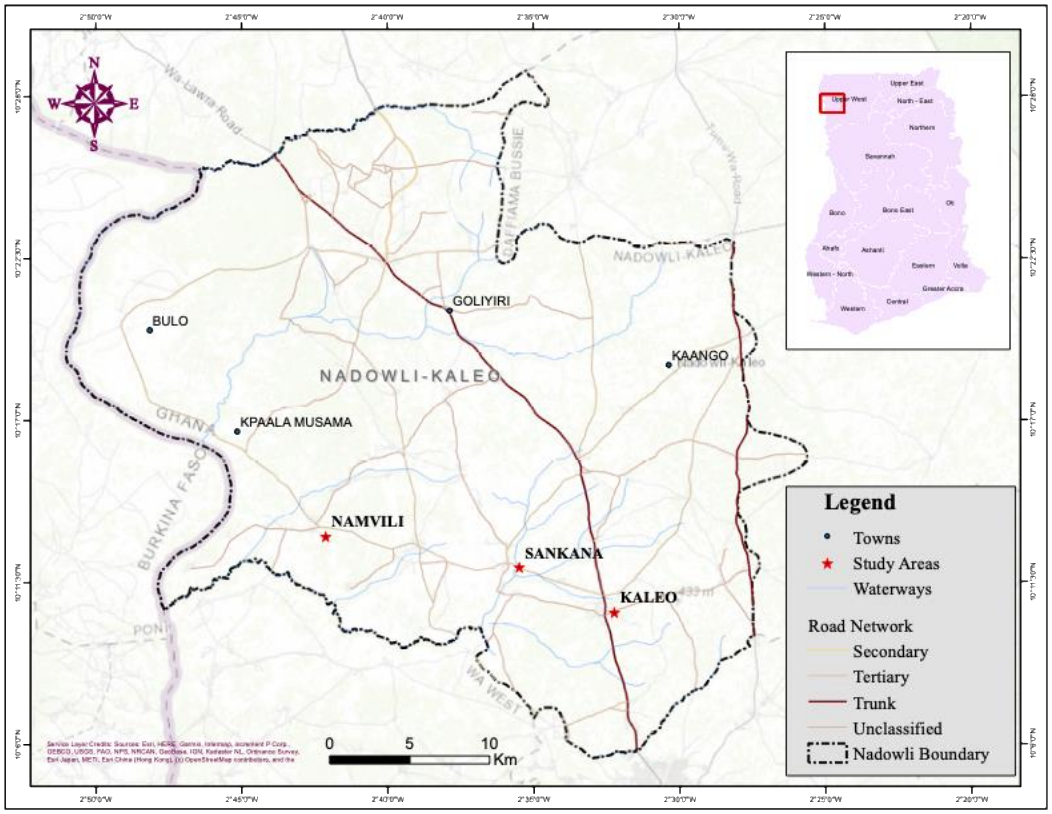

Figure 3.1 Map of Nadowli-Kaleo District showing Study Communities Source: Author's Construct

3.1.2 Population Structure and Distribution

According to the 2010 Population and Housing Census, the Nadowli-Kaleo District has a population of approximately 61,561 people. 28,753 (representing 46.71 percent) of the population are males and32,808 (representing 53.29 percent) of the population are females. In 2010 when the population census was conducted, youthful ages from 0-24 years representing 60.1 percent of the population was the highest, implying a promising economically active population capable of transforming the socio-economic and labour force fortunes in the district. The

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population was projected to reach 70690 people in 2016, with growth rate of 1.9 percent which represents about 8.8 percent of the region's total population. But the promising largely youthful population means that the growth rate will possibly increase.

The age distribution affects general fertility rate and ultimately the nature of changes that are likely to occur in the population (Ghana Statistical Service, 2012). Therefore, understanding the age and sex structure of the population is vital for the demographic and socio-economic development as well as labour force and gender related activities in the district. As noted by Abdul-Razak (2016) in his research study, knowing the population structure also contributes significantly to understanding a change in demographic components including mortality, fertility and migration dynamics of the district.

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3.1.3 Climate, rainfall and topography

The Nadowli-Kaleo district has a climate type that is common throughout the northern part of the country. Wet season and dry season are the two main distinct seasons in the Nadowli-Kaleo District. The dry season normally begins from November to March or April, whereas the wet season normally begins in March or May and ends in October. The District, like the rest of the region is characterized by cold harsh weather conditions and hot sunny weather. The cold weather conditions are caused by the dry north-eastern harmattan winds that starts

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in December and ends in March. This is followed immediately by the hot sunny weather which starts and ends on different dates as a result of change in climate.

The District also has a gently undulating low lying land at altitudes that ranges from 150m-300m above sea level. There are however some parts that average 600m. Bakpong is the one main stream that flows through the district. However, there are a few transitory streams that flow through the district into the Black Volta. Underneath the soil cover of the district also lies birimian, granite and basement complex rocks. These rocks hold considerable amount of water and can be developed. These streams, coupled with the fact that the rock type in the area is able to retain considerable amount of water over time helps in the construction of small dams, wells, boreholes and dog-outs across the district.

Whereas relative humidity is as low as 20% during the dry season, it ranges from 70% to 90% in the rainy season.

The District also has a mean annual temperature of 32^0C and a mean monthly temperature of about 36^0C in March to 27^0C in August. The District lies within the tropical continental or guinea savannah woodland with dry north-eastern harmattan winds that create harsh conditions due to the long dry season which occurs from October to March. This long dry period makes it impossible for farmers to farm throughout the year. It creates food insecurity, temporary loss of jobs (since 85% of the population are farmers) and out-migration particularly

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among the youth. Dams and dug outs are however constructed in most of the communities in the district to boost irrigation farming.

Nadowli District lies within the tropical continental or guinea savannah woodland characterized by shrubs and grassland with scattered medium sized trees. Some economic trees found in the District are kapok, shear, baobab, mango and dawadawa which are resistant to both fire and drought. These trees provide a major source of income to households particularly women who play important roles in the provision of household needs. These economic trees provide a potential for the establishment of processing industries to increase employment opportunities for the people.

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3.1.4 Soils

The soil cover of the District is sandy soil, sandy loam soil and laterite soil which are generally lacking in nutrients and also have poor organic matter due to the absence of dense vegetative cover. The absence of dense vegetative cover largely results from protracted erosion, bush burning and bad farming activities in the District. The eastern part of the District is made up of sandy loam soil that is more fertile enough for the cultivation of cereals, yam, legumes and rice compared to the western part of the District which largely have soil that is poor in nutrients and thereby limiting farming activities in the area

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3.1.5 Food Crop Farming and Irrigated Agriculture

According to the 2010 Population and Housing Census (PHC), 85 percent of the economically active population in the Nadowli-Kaleo district are into agriculture. The economy of the district is mainly agrarian however, crop and livestock production in the district are mainly subsistence. The subsistence farming creates lower levels of output and inversely lower levels of income. Millet, maize, sorghum, legumes, yams, beans and groundnuts are the major food crops cultivated in the district. Also, tree crops like dawadawa, shea, mango and cashew are also the major tree crop (cash crop) plantations found in the district. Dawadawa and shea are wild crops and can be found abundantly on farms in the district. Some farmers in the district are also engaged in rearing livestock which include cattle and ruminants among others.

Farmers in the district depend mainly on rain fed farming. However, due to the single maxima rainfall regime, which starts in March and ends in October each year, small-scale irrigation and dry season gardening are practiced in the District, using small dams, dugouts, wells and boreholes in the off-rainy season (November to mid-March). Some of the communities with typical small-scale irrigation projects in the study district are Sankana, Kaleo and Nanville. This study targeted farmers in such small-scale irrigation projects as sample units to ascertain how irrigation impacts on their livelihoods.

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3.2Research Methodology

The research methods used in the study were influenced by the type of research and what the study sought to unearth. Agrasuta (2013) refers to research methodology as the systematic, structured and focused data gathering and procedures that will address an identified research question or problem. It was therefore critical for this study to consider the appropriate research methods that could yield valid and reliable outcome. Nyantakyi (2017) noted that a research methodology is guided by the research questions and objectives, philosophy on which the research is grounded on, scope of existing knowledge, purpose of the study and focus of the study. This assertion is different from that of Burns and Grove (2003) who indicate that research methodology includes the research design, sampling, techniques of data collection and analysis and methodological limitations. This section of the study discussed the philosophical foundation of the research, research design, sampling design, sources of data, tools of data collection, techniques of data analysis, and ethical considerations.

3.3.1 Research Design

According to Choguill (2016), a research design is a well-defined plan that is structured to get responses to address a research problem. Creswell (2014) also describes a research design as a developed plan for the research activities undertaken to answer the research questions. This study therefore applied both explanatory and descriptive research designs in order to attain the aims and objectives of the study. The use of a descriptive method in this study provoked

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and addressed the `what' questions, while the explanatory methods addressed the 'why' questions. In other words, by the descriptive design, quantitative data was first gathered for addressing the research questions. The data were then presented using quantitative tools of presentation such as tables and charts, as well as absolute numbers and percentages to measure the dependent and independent variables as a requirement for achieving the study objectives.

However, quantitative data by means of descriptive methods give less detail. According to Harrison (2013), the outcome of quantitative analysis using the descriptive design is built on by the explanatory design by means of a qualitative data, in an attempt to give a better understanding of the quantitative outcome. This made the explanatory design necessary. In this study this was done by the use of narrations, explanations and direct quotations concurrently with the quantitative analysis.

In addition to the research designs, a multi-site cross-sectional case study was used. This was appropriate for the study of a single phenomenon in different settings. Accordingly, three different communities in the Nadowli-Kaleo District, namely Sankana, Kaleo and Nanville were selected for this study. Selection of the communities was based on criteria such as presently operational, accessibility and availability of basic information on small-scale irrigation farming. This enabled comparative analysis of findings.

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3.4 Sampling

This section describes the methods used in the selection of sampling units from the study population in the Nadowli-Kaleo District. The subsections below detail how sampling was done.

3.4.1 Sampling Techniques

The study employed both probability and non-probability sampling techniques. According to Olsen and George (2014), probability-based sampling is by randomization, which gives equal chances of selection to all elements of a population, and that this method of sampling must be taken into account for the purpose of generalizing results from a sample to a population. The fish-bowl method of simple random sampling as a probability sampling technique was used in selecting farmers that undertake small scale irrigation farming in the Nadowli-Kaleo District. This gave each member of the population under study, an equal opportunity to be selected. The fish-bowl or lottery technique was done by visiting the small-scale irrigation project sites. All irrigated plots were counted at the sites in each community and the total obtained. The target respondents were the owners of the irrigated plots who were 18 years old or older. For example, in Kaleo, the fish-bowl method was used, and codes were assigned to each plot on a piece of paper. These codes (numbers) were put in a box and mixed up properly by shaking it up. The pieces of papers with the assigned numbers were then picked one after the other without replacement from the box by all 42 irrigated

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plot owners until the required 32 proportionally distributed respondents (see section on sample size determination) was reached. The same process was repeated for Nanville to select 19 respondents out of the 26 total irrigation farmlands, and finally, 48 respondents from a total of 64 irrigated farmlands were selected from Sankana to attain the 99 sample size determined. The selected respondents were given a structured interview guide with close-ended questions. The researcher read out questions and the list of options for each question as answers for respondents to choose from.

The justification for the use of interview guide was to cater for illiterate farmers who could not read or write if questionnaires were issued. The use of close-ended questions was also to facilitate the acquisition of quantitative data for the quantitative approach in data analysis as a component of the mixed or descriptive research design.

Furthermore, the research study used purposive sampling procedure in selecting respondents with expert knowledge in the area of irrigation. Specifically, a semi-structured questionnaire with open-ended questions was issued to the regional office of the Ghana Irrigation Development Authority (GIDA) in the Wa Municipality of the Upper West Region, and an official was assigned to respond to it. In addition, leaderships of small-scale irrigation farmers in the study communities were also selected purposively for focus group discussions. The use

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of both probability and non-probability methods promoted cross-triangulation of findings to ensure validity, reliability and accuracy.

3.4.2 Sample size determination and distribution

The sample size was obtained through the Yamane (1967) formula for determining sample size which is $n=N/ [1+Ne^2]$. "N" represents the Sample frame and "e" represents the sampling error. Thus, N=132 represents small scale irrigation farmers, with a sampling error of 0.05 or 5%. So $n= 132/ \{1+ 132 (0.05)^2\}$ which is 99. Hence, 99 is the estimated sample size for the study. However, purposive sampling was also used for targeted individuals working in related institutions such as the Ministry of Food and Agriculture, Ghana Metrological Agency, the District Agriculture Development Unit and Non-Governmental Organizations.

Table 3.1 presents the distribution of the calculated sample size across the cluster of communities selected from the study district. The selected sample size was proportionally distributed across the three selected communities (Kaleo, Sankana and Nanville) based on the total number of farmers that are into small scale irrigation farming in each community. Using the proportional method of sample size calculation, the selected sample size of each of the three (3) communities was as follows:

Kaleo = 42/132×99=32

Nanville = 26/132×99=19

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Sankana = 64/132×99=48.

Table 3.1: Distribution of Sample Size

Name of Community	Sum of Irrigation Farmers	Determined Sample Size
Kaleo	42	32
Nanville	26	19
Sankana	64	48
Total	132	99

Source: Author's Construct, 2022**.**

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3.5 Sources of Data

The collection of data involves gathering and measuring data that is of relevance in a systematic way in order to enable a researcher come up with results that are able to extensively answer research questions and as well as address research aims and objectives in a research study. This study therefore considered both primary and secondary sources of data. The primary source of data mainly targeted information from farmers in small scale irrigation dam communities and the secondary source of data largely came from existing literature, documents and reports from institutions that were relevant to the study.

3.2.1.1 Secondary Data

Secondary data was obtained from existing literature and documents such as journals, manuals, books, articles and related thesis, reports, magazines, statistical data, newsletters and newspapers, websites, policy documents and standards among others that are related to small scale irrigation farming. These secondary sources of data are readily available and relatively cheaper to access

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(Onwuegbuzie & Leech, 2014). The use of secondary data cuts down cost, limit the resarech duration, exposes research niche and knowledge gaps, and at the same time make a lot of data available enough for the study to explore in-depth information on small scale irrigation farming in the Nadowli-Kaleo District.

Furthermore, relevant reports and publications of the Ministry of Food and Agriculture, Ghana Irrigation Development Authority, Ghana Meteorological Agency and the District Agriculture Development Unit concerning climate variability and initiatives targeted at irrigation farming were utilized.

3.5.1 Primary sources

Primary sources of data are information gathered for the first time from the field during a research study. As a result, the study gathered information directly from farmers that are into small scale irrigation farming and farming related activities in the Nadowli-Kaleo District. The information of farmers that undertake small scale irrigation farming were collected at the field using research tools and techniques such as observations, questionnaires, key informant interviews and focus group discussions. Given the use of primary source of data, biasness in views of previous works and current responses from respondents were effectively checked, and the reliability and dependability of the outcome increased as well (Abdul-Razak, 2016).

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As stated by Olsen and George (2014), the design of questionnaire merely represents a step in the process that ultimately results in answers the research questions of interest. Both closed and open-ended questions were designed to include demographic characteristics of respondents, as well as climatic and non-climatic variability that affect small scale irrigation farmers in the Nadowli-Kaleo District. Focus group discussion which is known as a more participatory method of data collection was employed in the study. As shown in a study by Twumasi (2017), a discussion with a group of 6 to 10 participants was adopted. The discussion was led and guided by a facilitator and focused on issues of climate variability and the impact on development of small scale irrigation dams. This helped bridge the gap between knowledge based on science and societal knowledge from key stake holders.

3.5.2Methods of Data Collection

Data collection includes information of interest that is gathered by a researcher and measured systematically to be able to answer research questions in a research study. In collecting primary data, the study considered employing survey questionnaire in collecting information from small scale irrigation farmers from the field. Survey questionnaire as a research instrument for data collection was considered by Dalari and Gomez (2018) as one of the classical approaches and methods of primary data collection. Questions of the survey questionnaire were both structured and unstructured. Interviews and observation as another method of primary data collection was also used in obtaining information from the farmers

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and farmlands respectively. The use of interviews was to explore individual opinions, beliefs, experiences and motivations on specific matters and also gain deeper understanding of social occurrences (Gill, Stewart, Treasure & Chadwick, 2014).Questions on the interview guide covered farmers' experience, climate change and the impacts of climate change in the selected communities. Observation was employed for validation and reliability of findings as well as seeing at first hand the activities of the small scale irrigation farmers.

The study also employed Focus Group Discussions (FGD) to obtain information on the knowledge and experiences of farmers that undertake small scale irrigation farming in the three selected communities. The use of FGD helped in exploring the connection between farmers' perception and socio-cultural situation which is vital to decision-making on natural resources since majority of human beings derive their understandings, constructions and interpretations from their immediate surrounding and nurture them from empirical knowledge (Nyumba, Wilson, Derrick & Mukherjee, 2017). These discussions were facilitated by the researcher and included issues of climate change, impact of climate change in the three communities, challenges of climate change and interventions targeted at addressing those challenges. The focus group discussion consisted of 6 to 8 (excluding the researcher) participants for each of Kaleo, Sankan and Nanville. Gill, Stewart, Treasure & Chadwick (2012) noted that FGD can still work a minimum of three and as many as fourteen participants, although small number of

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participants could bring about limited discussion and a larger number of participants could be chaotic, frustrating and difficult to manage.

3.6 Data Analysis

Both quantitative and qualitative data were gathered for the purpose of answering the research questions and as well as achieving the objectives of the study. Quantitative, data obtained through closed-ended questions on a structured interview guide administered to irrigation farmers were entered into Statistical Package for Social Scientist (SPSS) version 20. Tables and chats on frequency distribution were then generated from the data set for descriptive statistical analysis. To test the research hypotheses, inferential statistics was used. In other words, Chi-Square test was done using SPSS commands to test the hypotheses, using a p-value cut-off point of 0.05 for statistical significance of relationships between selected variables.

Qualitatively, direct quotations, narrations, explanations and sometimes tables were used to present and analyses qualitative data, obtained from responses to focus group discussions conducted for irrigation farmers and interview guide administered to GIDA officials using open-ended questions. Both quantitative and qualitative data presentation and analysis were done alongside the under analytical themes derived from the research questions.

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CHAPTER FOUR

FINDINGS AND DISCUSSIONS

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4.1 Introduction

This chapter presents the research findings based on the field survey and document reviews with detailed analysis and discussions. In general, this chapter is divided into four parts. The first part assesses the demographic characteristics of respondents to understand the relationship between their personal characteristics and irrigation farming. The second part provides an assessment of the nature of smallholder irrigation farming in Nadowli-Kaleo District, whereas the third section explores how irrigation farming affects livelihoods of smallholder farmers in the District. The final section considers the challenges faced by the farmers and the strategies they can employ to achieve better improvement their household livelihoods in the District.

The analysis of the data in this chapter followed the approaches of the mixed research design, with quantitative and qualitative approaches. Accordingly, the adopted philosophical paradigms were positivism and phenomenology, with the corresponding epistemological positions of objectivism and subjectivism.

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4.2 Demographic Characteristics of Respondents

The socio-demographic characteristics of respondents indicate data on sex, age, educational background and household size. The aim is to determine how these characteristics influence livelihood of small holder irrigation farmers in the Nadowli/Kaleo District. Table 4.1 shows a presentation of the demographic characteristics of respondents in the selected communities of the Nadowli/Kaleo District.

Table 4.1: Demographic Characteristics of Respondents

Characteristic	Group	Percentage
Age	15-45	40.4%
	46-59	31.6%
	60 above	27.4%
	Total	100%
Sex	Male	63**%**
	Female	37**%**
Marital Status	Single	14**%**
	Married	84**%**
	Divorced	-
	Widowed	2%
Level of Education	No Formal Education	63%
	Basic/ Junior High School	22**%**
	Middle/ Senior High School	11%
	Tertiary	4%
Household Size	1-5	23.1%
	6-10	36.5%
	11-15	23.1%
	16+	17.3%

Source: Field survey, February, 2022

As presented in Table 4.1, 63% of the respondents were male irrigation farmers while the remaining 37% were female irrigation farmers of varying age ranges. In

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response to the question of participation in irrigation farming by gender during a focus group discussion with small-scale irrigation farmers in Kaleo, a respondent stated that "*Male farmers dominate in the Nadowli/Kaleo District because farm lands are traditionally vested in the hands of males whereas most females assist their husbands on the farms".* This falls in line with what has been observed by Zakaria et al. (2019), who noted that there are great gender and economic inequities in access to land, housing and basic infrastructure in developing countries such as Ghana.

While males dominated in small-scale irrigation farming in the Nadowli-Kaleo District, interview with the Regional Agronomist of the Ghana Irrigation Development Authority (GIDA) yielded results that are contrary to this finding. Responding to the question on level of female participation in small-scale irrigation farming, the officer stated that "*I am not sure, but the number of women involved in small-scale irrigation farming is more than the men"*. Findings of Aabeyir and Bukari (2019) give evidence of reasons why females could dominate the small-scale irrigation sector of the Upper West Region. The authors reported the activities of the Center for Indigenous Knowledge and Organisational Development (CIKOD) through community resilience to climate change projects in the Lawra Municipality and Nandom District. Under the project, women gardeners were put into groups and provided with groundwater irrigation schemes with fenced gardens.

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The age of respondents ranges between 18 years to about 60 years. About 40.1% of the respondents fall within the age group of 15-45 years whereas 27% are between the ages of 40-50. About 31.6% of the respondents fall within the ages of 46-59, and the remaining 27.4% fall within the age ranges above 60 years. Also, from the ages 15-45 years indicates the active labour group and they were the majority of respondents. This certainly has implication for employment, household income and migration. Small holder irrigation farming serves to retain the youth in dam's communities during the dry seasons.

From Table 4.1, majority representing 63% of the respondents indicated that they have no formal education whereas 22% of the respondents indicate that the highest level of education attained was that of either basic or Junior High School (JHS) level. About 11% of respondents attained middle or High School level whilst the remaining 4% attained tertiary level of education of which college and undergraduate levels where dominant among the few respondents who attained this level yet practice irrigation farming.

Although illiterates dominated the small-scale irrigation sector of the study area, in a focus group discussion with irrigation farmers in the Sankana Community, a participant noted that:

> We do not receive extension services on improved methods of irrigation as much as we wish to have. However, the educated ones among us are more willing to enquire, learn on their own, or through knowledge of farm or irrigation practices from school, are able to show innovation in their

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irrigation farming practices. Also, some of the educated farmers are formal sector employees who do irrigation farming on part-time. So they are able to use their incomes to acquire better inputs to improve their farming.

Out of the 99 respondents of the study, 84% were married whereas 14% were single and 2% are widowed with household sizes ranging from 1 to over 16 people. Also, 23% of respondents indicated that they have household sizes of between 1-5 people, where as 37% have household sizes of 6-10 persons and the remaining 23% and 17% of the respondents have household sizes of between 11-15 and over 16 persons respectively. According to Aabeyir and Bukari (2019), marital status and household size are interrelated and contributory to the economic burdens of household heads in terms of meeting basic needs of household members, and thus, accounts for the reasons why married people dominate in small-scale irrigation farming and market gardening.

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4.2.1 Participation in small-scale irrigation by respondents

The study revealed that an appreciable number of respondents practice irrigation farming as a way of boosting their economic activities. Figure 4.1 shows results of respondents' participation in small-scale irrigation farming.

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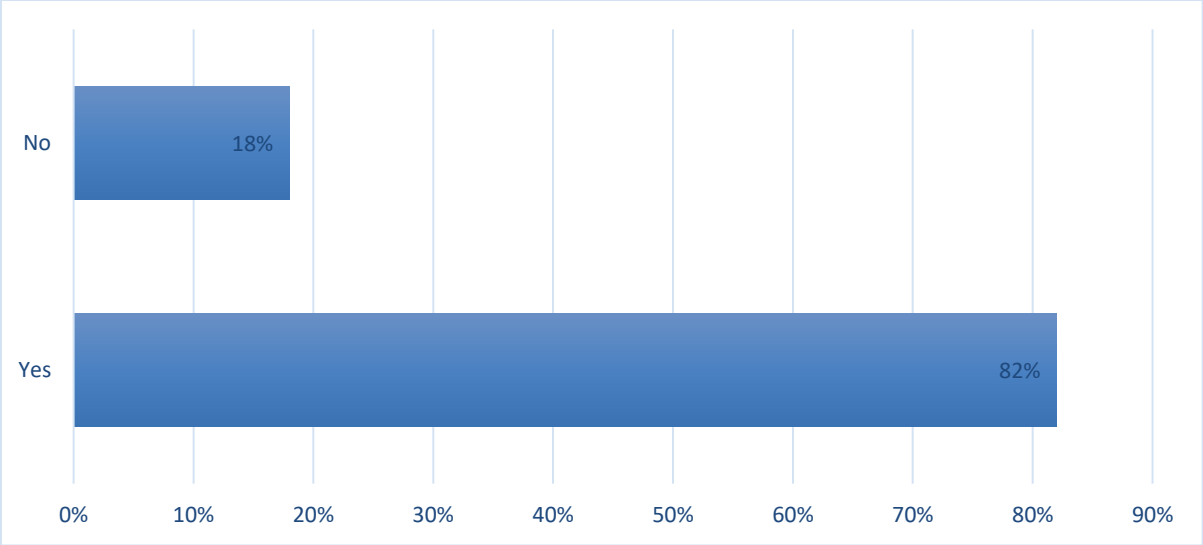

Figure 4.1; Practice of irrigation among respondents

Source: Field survey, 2022.

As shown in Figure 4.2, 82% of the smallholder irrigation farmers contacted indicated that they practice irrigation farming and owned plots at the irrigation site. However, 18% chose the 'No' option because they did not own the plots included in the sample, but were found there as relatives of the farmers, who were absent when the researcher visited the sites to administer the instruments.

However, informal conversation with those who responded 'No' to the question of practicing irrigation farming showed that if they got plots of land they would practice it. Most of such respondents were women who met the age specification (18 years) for inclusion in the sampling unit. The study found that generally, men find it easy to access land than women to practice small scale irrigation farming. Table 4.8 showed the level of difficulty between men and women in their effort to access land for irrigation farming in Nadowli/Kaleo District.

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Table 4.2: Level of Difficulty in Accessing Land for Irrigation by Gender

Gender Group	Responses					Rank
	Very Difficult	Difficult	Somehow Difficult	Not Difficult	Weighted Average	
Male	11%	14%	7%	3%	1.03	2nd
Female	33%	20%	9%	3%	2.13	1st

Source: Field survey, 2022

The results in Table 4.2 showed that, on average, females (women) in the District have more difficulty accessing land than their male counterparts. This was evident as 33% and 20% attested to the fact that it is very difficult for women to access land whereas only 3% of them believed that it is not difficult for women to access land. This confirms what was observed by Mainu (2022), that in patriarchal societies such as those of Northern Ghana, access to land is male dominant. However, where a few women own lands, it is either by acquiring it through some user factory land ownership rights, or mostly through their sons who inherited lands from their diseased fathers but work in the formal sector and so do not do farming or are too young to farm. In the latter case the women could till the land until the sons are grown enough to take full ownership of the land.

4.2.3 Household income of respondents

In terms of income as a characteristic of the respondents, the annual income level of smallholder farmers is assessed and the results are shown in Figure 4.2.

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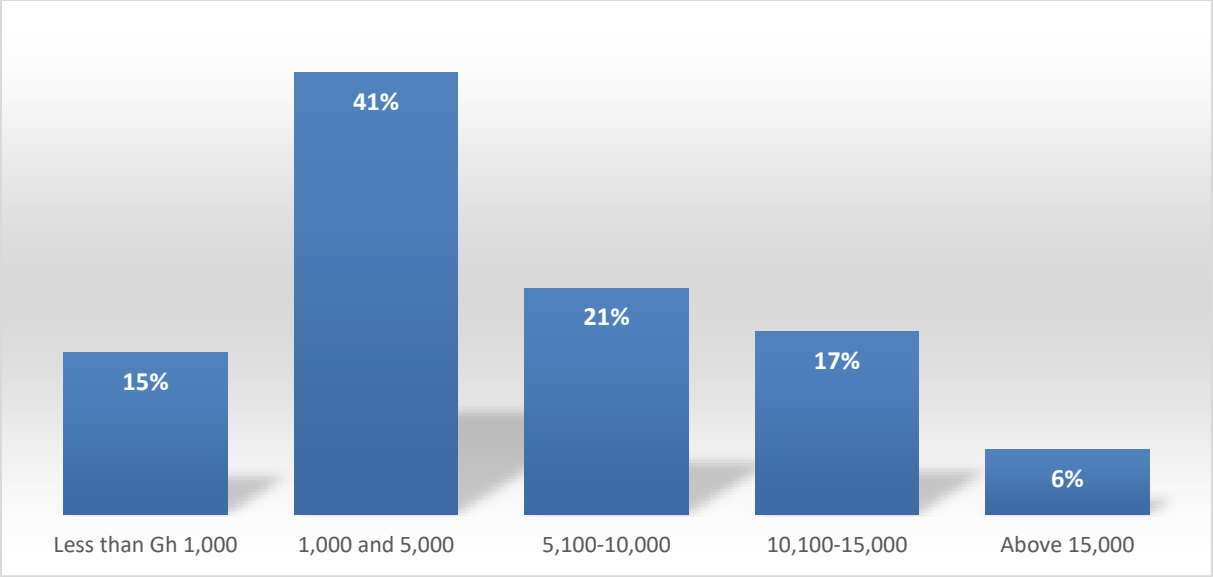

Figure 4.2: Annual Income Level of Smallholder Farmers

Source: Field Survey, (2022)

As shown in Figure 4.3, majority of smallholder farmers in the Nadowli/Kaleo District earn between Gh1,000 and Gh5,000 annually. This was evident as 41% indicated that they received between Gh1,000 and Gh5,000 from their activities annually. Also, 15% of them received less than Gh1,000 in a year whereas only 6% of them received above Gh15,000. Like in other communities across the African continent, smallholder farmers in the Nadowli/Kaleo District who are mostly women are earning less, who are mostly rural, earn less than the mean annual household income of the Upper West Region, which is Ghc12, 958, based on the Ghana Living Standards Survey Round 7 (Ghana Statistical Service, 2019). The findings therefore imply that small-scale irrigation in the study district is not measuring up to the target of the irrigation policy of Ghana, which is about increasing livelihood options, such as improved income generation (MOFA,

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2014). This is because the standard of living of the average smallholder irrigation farmer in the Nadowli-Kaleo District is below the regional average.

4.3 Nature of Small-scale Irrigation Farming

This section addresses the first research question of this study, which is about the nature of small-holder irrigation farming in the Nadowli-Kaleo District. This aspect of the study examines the peripheral issues, corroborating with the general thesis of the Theory of Planned Behaviour (TPB), which explains all the intended behaviors over which people have the ability to exert self-control. The analytical trajectory of this section is also shaped by the first thematic component of the conceptual framework of this study, which is about the nature of irrigation (Figure 2.2). Accordingly, this section investigates into the environmental/climatic and socio-economic conditions which small-holder irrigation farmers in the study area try to manipulate to improve their livelihoods (Nkhoma, 2015).

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4.3.1 Rainfall conditions that influence irrigation farming

Table 4.3 shows the views of respondents on the rainfall conditions that necessitate irrigation farming in the Nadowli/Kaleo District of the Upper West Region. The study revealed that the nature of rainfall is deterministic in their participation in irrigation farming. Out of the 99 respondents 88% agreed to this while 12% thought otherwise. This implies that majority of the respondents were of the opinion that the unpredictable nature of rainfall in the district contributes largely to this situation. This finding is consistent with the Sustainable

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Livelihoods Framework, which identifies unexpected climatic conditions such as drought as shocks, while the adoption of irrigation farming as a response corresponds with intention or motivation tenet of the Theory of Planned Behavior (Larmot, 2019).

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Table 4.3: Nature of Rainfall Necessitating Irrigation Farming

Irrigation is necessitated by rainfall nature	Frequency	Percentage
Agreed	12	12
Disagreed	87	88
Total	**99**	**100**
Condition	Frequency	Percentage
Late rainfall	44	44.4
Shorter duration of rain	34	34.3
Inadequate rainfall	22	22.2
Total	**99**	**100.0**

Source: Field Survey, 2022

Table 4.3 shows that respondents also mentioned three major features of rainfall in the District. These include late rainfall or rainfall beginning late, shorter duration of rains and inadequate rainfall in the district. Majority of the respondents constituting about 44.4% revealed that the main effect of rainfall is the late beginning of the rains. A focus group discussion participant in Kaleo noted that:

> In the past decade's rainfall began early and lasted longer. As a result, water levels of wells and dams were high, hence encouraging irrigation farming in the dry seasons. But in recent times, due to increasing changes in climate related factors, the levels of water in surface and groundwater sources reduce drastically during the dry seasons. This as a result of

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inadequate rainfall, short duration of rainfall, coupled with high temperatures that cause excessive evaporation of water in the irrigation dams.

The assertion of the respondent above is supported further by Table 4.3, which reveals 34.3% of responses recognizing shorter duration of rainfall, and 22.2% also identifying inadequate rainfall in the district.

4.3.2 Effects of rainfall on crop cultivation

Table 4.4presents the views of respondents about some of the ways by which rainfall affects food crop farming.

Table 4.4: Effects of Rainfall on Food Crop Farming

Effects of rainfall on food crops	Frequencies	Rank
Crops mature adequately within the rainy season	0	-
The rains ends before the crops mature sometimes	51	1st
Rainfall is irregular and affects crop development	30	2nd
The rain does not promote adequate crop yield	18	3rd
Rainfall promotes adequate crop yield	0	-

Source: Field survey, 2022

From Table 4.4, the effects mentioned by respondents include rains ending before the crops mature sometimes which was justified with a rank of 1st. About 51 respondents asserted that the major effect of rainfall on food crop farming was manifested by inadequate rainfall in the District.

About 30 respondents argued that the irregular nature of rainfall affects crop development and hence was ranked second. The land easily gets dried up because

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of irregular nature of rainfall, inadequate water or soil moisture hence the soils of the district get compacted and hard leading to difficulty in cultivation of food crops. A total of 18 respondents also claimed that the rain does not promote adequate crop yield in the Nadowli/Kaleo district.

The farmers expressed the view during informal conversation, that the unreliable nature of rainfall, which occurs once a year is the reason why irrigation farming is necessary. In an Interview with an official of GIDA in the Wa Municipality, about the effects of rainfall on crops, he stated that:

> To obtain a maximum yield, water must be applied to the crops before the soil moisture potential reaches a level at which the evapotranspiration rate is most likely to be reduced below its potential. To obtain a maximum yield, water must be applied to the crops before the soil moisture potential reaches a level at which the evapotranspiration rate is most likely to be reduced below its potential. About 99% of the water absorbed by plants is lost by evaporation and transpiration from the plant surface. Thus, a crop's water requirement is equivalent to evapotranspiration desires. However, evapotranspiration mainly depends on climatic factors. To obtain a maximum yield, water must be applied to the crops before the soil moisture potential reaches a level that could cause them to wilt and die due to excess of evapotranspiration over precipitation or rainfall. The nature of rainfall therefore has an impact on food crop farming. All vegetables and crops need water to grow and produce yields. The most important

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source of water for crop growth is rainfall. When rainfall is insufficient, water for irrigation activities may be affected hence the supply of water is not guaranteed which will certainly lead to poor yields.

Thus, inadequate rainfall exposes farmers to significant risk when seasonal changes and droughts occur, which explains why irrigation farming is necessary in the area. The scenario depicted in Table 4.4 reflects conditions of vulnerability of farmers to climate risks, which according to the Sustainable Livelihood Framework, could lead to the adoption of strategies to ameliorate such risks (De Stagé et al., 2014).

The findings also corroborate with the assertion by Larmot (2019), in his explanation of the motivation (intention) tenet of the Theory of Planned Behaviour, that some prevailing conditions serve as motivational factors which dictate stronger intentions to perform the certain behaviors. Hence, inadequate rainfall is the driving force for farmers' involvement in irrigation farming.

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4.3.3 Land acquisition for small-scale irrigation

In furtherance, the participants attested that acquiring a land at such projects sites has been extremely difficult. About 82% of the respondent were of the view that it is not easy to acquire a portion of land at the project site, 18% argued that they can still acquire portion of land at the project site. It was established from the findings that; the economic value of land has increased in the district following population growth and expansion in development from the regional capital to the Nadowli/Kaleo district. Landlords now protect their lands from the entry of others

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than before, making it difficult to use someone land for smallholder irrigation farming activities. Table 4.5 also shows conditions for acquisition of irrigation project sites in the communities.

Table 4.5Conditions for Acquiring Land at the Irrigation Project Site

Condition	Frequency	Percentage
Buying a plot of land	1	1.0%
Paying annual rent for the use of the land	3	3.0%
Sharing harvest of irrigation produce with land owner	10	10.1%
Direct ownership of land at the project site	85	86.0%

Source; Field Survey, 2022

From Table 4.5, the results suggested that 86% of the respondents agreed that land can be acquired at the irrigation project site through direct ownership of land, 10.1% believed that one can acquire land by sharing harvest of irrigation produce with land owner while 3.0% were of the opinion that in order to acquire land at the irrigation project site one need to pay annual rent for the use of the land. By inferring from the data, majority of the respondents assumed that the condition for the acquisition of land at irrigation has to do with direct ownership of land followed by sharing harvest produce with owner of land. In a focus group session with small-scale irrigation farmers at Sankana a respondent acclaimed that:

> All other places may be better, but for this community, how to acquire land for irrigation project is more than tedious. Each and every one will tell you a different story regarding the land and in worst scenario youth will take up arms against prospective developers. This actually made the acquisition of land for irrigation projects very difficult.

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This is consistent with assessment studies conducted by SEND Foundation (2018), which found that that access to land is one of the challenges faced by small holder farmers in irrigational farming. It is also linked to the assumption of the Sustainable Livelihood Framework, that institutional rigidities in the forms of customs and land tenure have implications on livelihood outcomes (Ellis, 2016). In Ghana, almost 80% of lands are possessed by the communities entrusted by the chiefs. Accessing such lands for farming is a major challenge for small holder farmers in the country.

4.3.4 Factors influencing participation in small-scale irrigation

Table 4.6 shows some of the factors that influence respondents' participation in irrigation farming. It was by multiple responses. In other words, respondents were not restricted to choosing only one or two options. They could agree or disagree with the options for the question as they did, or did not apply to them. From Table 4.6, the result showed that inadequate crop yield during rainy season was considered as the most important factor that influences small scale farmers to participate in irrigation as it was ranked first.

Table 4.6Factors that influence participation in irrigation farming

Factor	Frequency	Rank
Inadequate crop yield during rainy season	98	1st
Diversification of occupation	81	4th
A source of supplementary income	93	2nd
Avoiding seasonal unemployment	86	3rd
Lack of land for farming in the rainy season	72	5th

Source; Field Survey, 2022

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This was followed by a source of supplementary income which was ranked second. The results again depicted that avoiding seasonal unemployment was a factor determining small holder farmers to participate in irrigation farming. The least ranked factor was lack of land for farming in the rainy season. This finding corresponds to the dictate of the conceptual framework of this study in Figure 2.2, that apart from the socioeconomic characteristics of the participants and other conditions of irrigational infrastructure, farmers also have reasons for engaging in irrigation, which are obvious in the data presented in Table 4.6 and also conform to the motivation tenet of the Theory of Planned Behaviour. In other words, the responses reflect what motivates a farmer to participate in irrigation.

4.3.5 Size of smallholder irrigated lands

This segment of the study determined the sizes of irrigated lands cultivated by the small-scale scale farmers in the study communities. Table 4.7 also presents the results.

Table 4.7 Size of Irrigated Land

Average size	Frequency	Percentage
Less than one acre	84	85.0%
One acre	11	11.1%
More than one acre	4	4.1%

Source; Field Survey, 2022

Based on the field data, it revealed that 85.0% possessed average of irrigated land less than one acre, 11.1% of the respondents controlled average irrigated land of one acre whereas 4.1% had average irrigated land of more than one acre. This

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means that majority of the respondents owned less than one acre of irrigated land. During a Focus Group Discussion at Nanville, a small-scale irrigation farming commenting on the sizes of land cultivated by farmers stated that:

> We cannot extend our farms to other farmer's plots beyond the land allocated for irrigation. This will lead to conflict and subsequent affect the sustainability of the small scale irrigation farming as we have witnessed before some years back, hence, the need to tread cautiously.

The focus group discussions and field observations also showed that smallholder irrigation farmers cultivate small pieces of land because the main source of water for irrigation in the communities is the well. Most of the wells were constructed with the aid of some NGOs and the District Assembly. The well water is not adequate to support large pieces of land for irrigation. If more people owned lands to depend on the water from a single well it dries up easily due to too much use of the water. The situation reported at the Nanville community also means that the Government's One-Village –One Dam programme, which was intended to support irrigation farming in villages of Northern Ghana to avert the effects of inadequate rainfall (Mensah, 2020), has not been extended to the community.

The above findings fall in line with a study by Namara et al (2011) that there is not enough available land, hence a scanty room for irrigational expansion. Ghana Irrigation Report (2014) also reveals that in the northern part of the country there is vast land, yet faced with the lack of irrigable area due to inadequate water

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resources to support irrigation. This generates interest in the type of crops cultivated under irrigation in the area.

4.3.6 Irrigated Crops Cultivated

This subsection examines the types of crops cultivated under irrigation in the study area. The study found that the common crops cultivated on small-scale irrigation sites, as presented on Table 4.8 were vegetables, plantain and cereals.

Table 4.8: Crops Cultivated on Irrigated Land

Crops cultivated on irrigated land	Frequency	Percentage
Vegetables	88	89%
Cereals	1	1.1%
Plantain	10	10.3%
Total	99	100.0%

Source; Field Survey, 2022

The most dominant crops cultivated on the irrigated lands were vegetables with 89% response rate. Examples of the cultivated vegetables are cabbage (Brassica oleraciavarcapitata), tomatoes (Lycopersicumesculentum), cow pea leaves (Viciaspp) and lettuce (Latuca sativa), pepper (Piper nigrum), bell pepper (Capsicum annuum.spp.), okro (Abelmoschusesculentus), and garden eggs (Solanum melongena). Apart from the above, Bukari (2019), also observed the cultivation of common beans (Phaseolus vulgaris L.) for their leafs as vegetables.

In addition, 10.3% of the respondents cultivated plantain (Musa paradisiaca), whereas 1.1% of the respondents cultivated cereals on the irrigated lands, especially maize (Zea mays). Vegetables dominate irrigation farming in the area because they require shorter time to mature, while plantain is cultivated because it

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is a perennial agro-forestry crop with broad leafs for the protection of vegetables, especially seedlings on irrigated plots, against the direct effects of sunshine. How the production of these crops under irrigation impacts on livelihoods is of major interest in this study and has been examined in a later part of this thesis.

4.3.7 Ownership of irrigation projects

This section presents respondents' understanding of the ownership of the infrastructure for irrigation in the Nadowli-Kaleo District. Table 4.9 presents the results.

Table 4.9 Nature of Ownership of Irrigation Projects

Ownership of irrigation project	Frequency	Percent
Government owned	58	59.0%
NGO funded	32	32.0%
Community owned	7	7.0%
Donated by philanthropist	2	2.0%
Total	99	100

Source; Field Survey, 2022

The data on Table 4.9 revealed that 59.0% of the irrigation dams were owned by the government, 32.0% were owned by Non-Governmental Organizations, 7.0% of the facilities were owned by the communities themselves while 2.0% were donated by philanthropist. This implies most of the irrigation projects in the Nadowli/Kaleo District were constructed by the central government, through the District Assembly.

Althoughthe activities of irrigation farmers are monitored by GIDA, the small nature of the dams is characteristic of non-formal type of irrigation, which according to GIDA (2014), takes the form of small reservoir-based communal

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irrigation systems, with substantial contribution of beneficiary communities, but could involve GIDA, donors or private contractors as stakeholders. This position of GIDA goes in line with the Thrust B, of the National Irrigation Policy of Ghana, which anchors on socio-economic inclusion as it advocates for removal of constraints to a balanced socio-economic engagement with land and water resources (MOFA, 2014).

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4.3.8 Sources of irrigation water

Respondents were asked to identify the major sources of water smallholder irrigation farmers depended on in the district, and the results are presented on Table 4.10. It shows that dams, wells and dug-outs are the major sources of irrigation water. The least ranked was stream/rivers with the reason that they easily dry up during the dry season. From the data, it was realized that majority of the respondents in the Nadowli/Kaleo district into small scale irrigation farming use dam water in their agricultural activities.

Table 4.10 Main Sources of Water for Irrigation Project

Sources of water	Frequency	Percentage
Stream/river	3	6th
Dam	43	1st
Dug-out	18	3rd
Mechanized bore-hole	4	5th
Well	24	2nd
Reservoir	7	4th

Source; Field Survey, 2022

During a focus group discussion session at Kaleo, a respondent attested that:

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> Our sources of water for irrigation farming have been very poor. Immediately the rains stop all the water bodies dry up, even our animals cannot get good water to drink. That is why we only resort to few shallow wells and small dams constructed by government and NGOs as the source for irrigating smallholder farms.

In an interview with an official of the Ghana Irrigation Development Authority about the distribution of various types of irrigation schemes in the Nadowli-Kaleo District, he stated that there are about six public surface irrigation schemes in the district. He also provided the details in Table 4.11 below.

Table 4.11: Distribution of Types of Irrigation Schemes

Locality	Type of Irrigation System	Type of Ownership (Public/Communal/Etc.)	Number
Entire District	Formal	Public	6
Kaleo	Shallow wells	Communal	1
	Small dam	Public	1
Nanville	Shallow wells	Communal	1
Sankana	Gravity with some private individual pumps	Communal with government supervision	1

Source: Field survey, 2022.

The interview with the GIDA official also confirms that formal sector irrigation schemes, usually in the form of dams dominate in the district, as identified by the respondents in Table 4.10, in the three study communities, shallow wells was also ranked second. The schemes are also largely communally owned with supervision by Government through GIDA. The information obtained above now

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paves the way to see how the combined effects of irrigational infrastructure and crops cultivated have on the livelihoods of smallholder irrigation farmers.

4.4 Effects of Irrigation on Livelihoods of Smallholder Households

This section addresses the second objective of the study, which is about the effects of smallholder irrigation farming on household livelihoods of the farmers. The analytical trajectory of the section is also dictated by the linkages between proposition of the Theory of Planned Behaviour, that is, how intentions to implement irrigation schemes go a long way to promote the ability to manipulate livelihood options to the advantage of the participants (Lamorte, 2019).

Table 4.12 also presents results of interview with a GIDA official. The results show key stakeholders identified by the official and their roles for the promotion of irrigation, which could lead to livelihood improvement. The data shows that the key stakeholders in the irrigation sector in the study district include GIDA, responsible for the development and management of irrigation schemes; NGOs, responsible for capacity building; and households, serving as beneficiaries as they participate directly in irrigation activities for their livelihoods.

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Table 4.12: Stakeholders and their Roles in Irrigation Farming

Name of stakeholder	Location of the stakeholder (which district in the region?)	Sector (e.g. public/formal, private/non-formal, communal)	Role of the stakeholder
GIDA	Region	Public	Development and management
NGOs	Region	Private	Capacity building
Households	Communities	Communal	Direct participation in irrigation farming and collaboration with other stakeholders

Source: Field survey, 2022.

Table 4.13 presents the livelihood indicators of the effects of irrigation as reported by respondents.

Table 4.13: Livelihood Indicators of the Effects of Irrigation

Household Consumption	Before engagement		During engagement	
	Frequency	Percentage	Frequency	Percentage
Once a day	50	50.5%	21	21.2%
Twice a day	31	31.3%	49	49.5%
Three times a day	16	16.1%	26	26.3%
Four or more	2	2.0%	3	3.0%
Total	99	100%	99	100%
Income levels before and during engagement	Frequency	Percent		
No change	10	10.1		
It has improved	61	62.0		
No improvement	18	18.2		
No income	10	10.1		
Total	100	100%		
Effects of irrigation on other household needs	Frequency	Percentage		
Cater for health insurance	72	72.7%		
Cater for household shelter	18	18.1%		
Cater for clothing of household	9	9.0%		
Total	99	100%		

Source: Field Survey, 2022

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The results from Table 4.13 show that household consumption levels increased during engagement in irrigation than before. This is because majority of the respondents used to have meals once a day before participation in irrigation, which increased to twice a day or three times a day after they started practicing irrigation. During a focus group discussion at Kaleo, a participant acclaimed that:

> The importance of small holder irrigation farming cannot be downplayed. Even the most poverty endemic households who could not previously fend for their families can now feed their families adequately, thanks to the advent of smallholder irrigation farming.

Another respondent at Nanville had this to say: *"*The fact remains that household consumption has seen an improvement for households that embraced irrigation farming in the Nadowli/Kaleo District".

Table 4.13 further shows that 62% of the respondents were of the view that income levels improved tremendously during the engagement of the irrigation farming compared to before the engagement. This means that with the advent of irrigation farming in the study community, majority of the farmers have seen improvement in their income levels. During a focus group discussion at Sankana, a participant asserted that:

> Frankly speaking, how to pay my children's school fees was a problem but since I engaged myself in the smallholder irrigation farming, I can now pay their fees at ease. It's obvious that income levels of all households who participate in irrigation farming have improved in this community

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than before. This calls for government to intervene and expand the activities of small holder irrigation farming.

In terms of other household basic needs as indicators of livelihood, Table 4.13 reveals that out of the 99 respondents, 72.7% were of the understanding that the main impact of irrigation farming on households was the ability to cater for their health insurance needs. This was followed by their ability to cater for household shelter with a rating of 18.1% while 9.0% of the respondents thought that their participation in irrigation farming enabled them to cater for their household clothing needs. During a focus group discussion, a participant at Sankana posited that:

> Since I went into irrigation farming I have been able to cater for my family health needs. With this, I made sure that all my health insurance needs are taken care of. Even now I do take care of other friend's health insurance needs and have also been able to save some amount from my harvested crop proceeds, which enables me to contribute to other community development needs and social events such as child naming, weddings and funeral ceremonies.

The above findings fall in line with other empirical studies. For instance, Mainu (2022), report that participation in smallholder irrigation farming improves food security and reduces poverty among households. According to Namara, Makombe, Hagos and Awulachew (2008) and Xie *et al.* (2014), the utilization of

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irrigation water does not only contribute to increase in crop yields per hectare but also contributes to improvement in household incomes.

Responding to a question on how effective the roles of stakeholders have been in terms of impacts on livelihoods of smallholder farmers in irrigation, a GIDA official presented his observations as detailed in Table 4.14 (see the extreme right column of the table).

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Table 4.14: Effectiveness of the Roles of the Stakeholders on Improving Livelihoods

Name of stakeholder	Name and location of irrigation scheme in the NKD	Specific role played	Aspect of livelihood of small-holder irrigation famers impacted	Evidence of effectiveness of the impact of the stakeholder role on livelihood of farmers
GIDA	Sankana Irrigation scheme	Development and management	Incomes,nutrition and health	Sales of produce in the markets, Ability to cater for family domestic, health and educational needs
GIDA	Goli	Development and management	Increase in incomes, improved nutrition, health Ability to acquire personal properties	Sales of produce in the markets, Ability to cater for family domestic, health and educational needs
GIDA	Nanvili	Development and management	Increase in incomes, improved nutrition, health Ability to acquire personal properties	Sales of produce in the markets, Ability to cater for family domestic, health and educational needs
GIDA	Duong	Development and management	Incomes increase, improved nutrition, health Ability to acquire personal properties	Sales of produce in the markets, Ability to cater for family domestic, health and educational needs
GIDA	Kaleo	Development and management	Incomes increase, improved nutrition, health Ability to acquire personal properties	Sales of produce in the markets, Ability to cater for family domestic, health and educational needs

Source: Field Survey, 2022.

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Inferential statistical test was also conducted as a component of the quantitative approach adopted for this study. Chi-square test was used to test the hypotheses of the study, which are repeated in Table 4.15 with the results of the test. The results measure the statistical significance of the relationship between the practice of irrigation farming and various variables of livelihood, specifically employment status, income and food security (e.g. number of meals per day). Using a P-value cut-off point of 0.05, Table 4.15 shows that there were significant relationships between practice of irrigation farming and employment (p= 0.030), income (p=0.016) and food security (p=0.021). Accordingly, null hypotheses H01, H02 and H03 are rejected. In other words, any intervention to improve livelihoods through irrigation would have higher chances of success if targeted at employment, income and food security. The P values show that income had the best significant level, followed by food security and employment respectively.

Table 4.15: Chi-Square Test Results on Effects of Irrigation on Livelihoods

Hypothesis	$\chi 2$	Df	Asymptotic significance	Remarks
$H0_1$: There is no significant difference between irrigation farming and employment status of smallholder farmers.	4.651	1	0.030	The differences in responses are significant. Rejected null hypothesis
$H0_2$: There is no significant difference between irrigation farming and income levels of smallholder farmers.	5.821	1	0.016	The differences in responses are significant. Rejected null hypothesis
$H0_3$: There is no significant difference between irrigation farming and household food security of smallholder farmers.	5.221	1	0.021	The differences in responses are significant. Rejected null hypothesis

Source: This study, 2022.

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The findings about the effects of irrigation farming on livelihoods of the households of smallholder farmers are in conformity with the policy targets of the National Irrigation Policy of Ghana, which focus on "national food security; intensified and diversified production of agricultural commodities; increased livelihood options; optimum natural resource use; reduced negative environmental impacts; expanded investment space for irrigated production" (MOFA, 2011: 1).The gap in policy/programme influencing from the findings is the inability of the Government to extend the One-Village On-Dam programme to study communities.

4.6 Challenges facing smallholder irrigation farmers

This section addresses the third objective of the study by examining the challenges of irrigation farming in the study area. It also covers alternative ways of addressing the challenges.

4.6.1 Challenges faced by smallholder farmers

Irrigation farming among small holder farmers is hindered by numerous systematic and market restrictions. The systematic restrictions include infrastructure, trade duties, taxation, availability of labour, land tenure, access to water. On the other hand, the market restrictions include, lack of knowledge, inadequate finance, and ineffective supply chains. Figures 4.3 and 4.4, as well as Table 4.16 present respondents' views on challenges they face. From Figure 4.3, the results depicted that 48% of the respondent were of the estimation that the

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nagging issue facing their acquisition of inputs was the high cost of inputs at the open market, 24% were of the view that lack of capital for inputs has been troubling them in their attempt to acquire inputs for irrigation farming.

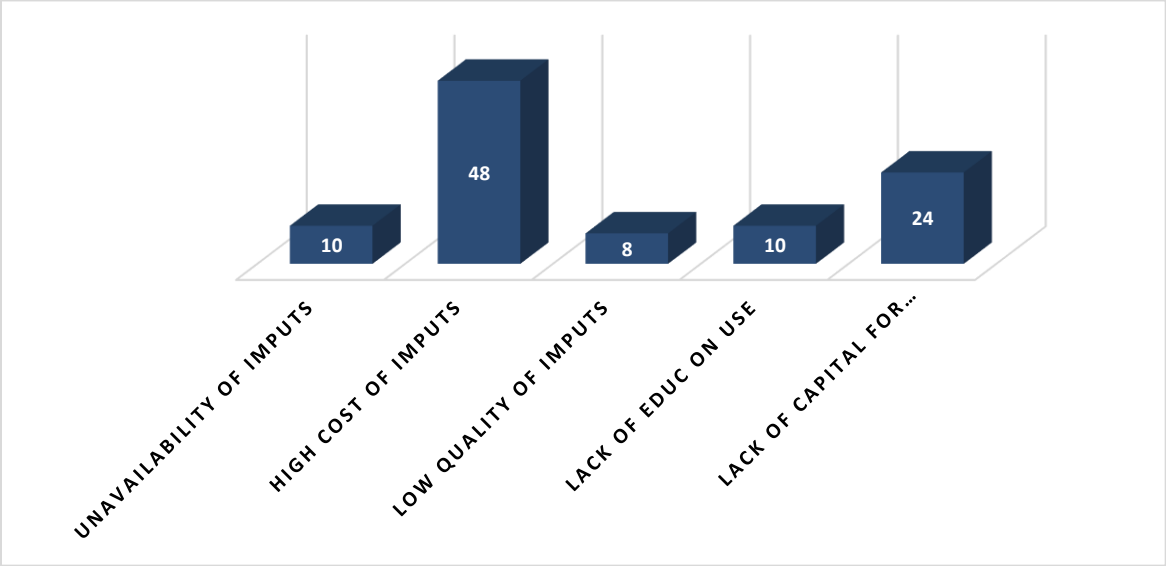

Figure 4.3Challenges faced in input acquisition

Source; Field Survey, 2022

Meanwhile, 10% in each case agreed that they encounter unavailability of inputs and lack of education on the use of the inputs as challenges facing input acquisition in the district. Also, 8% agreed that low quality of inputs was a challenge they face in their attempt to acquire inputs. In a FGD a participant at Nanville revealed that:

> One of the troubling factors facing input acquisition was the rocketing prices of farm inputs. Every irrigation implement/tool has witnessed an increase in price that is unbearable. This has the potential of forcing some

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irrigation farmers out of the market as they can no longer afford the needed inputs on their farm lands.

This is consistent with studies conducted by Namara et al. (2011) that one of the key pressing concerns is the limited availability of inputs and the high costs of procurement. Technologically, the lack of efficient well drilling and water lifting is a hindrance for the development of groundwater irrigation. Most irrigation suppliers are based in Accra and are expanding their operations to cover the northern part of the country. Irrigational equipment is often not sufficient to farmers in both quality and quantity required. Conversely, if farmers have access to equipment, they may not have the knowledge and experience to operate them.

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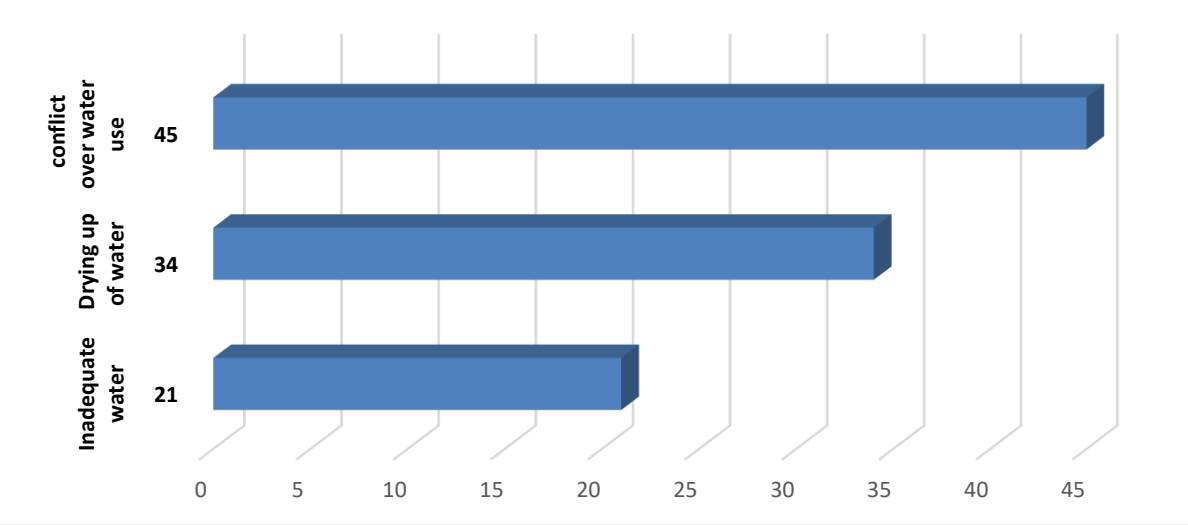

Figure 4.4. Challenges of availability of water for irrigation farming

Source: Field Survey, 2022.

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The availability of water has always been a constraint on irrigation farming activities across the globe. From Figure 4.4, about 45% of the respondents established that the fundamental problem facing water availability was conflict over the use of water from the irrigation project with other neighbouring communities. That is basically who owns and who has the right to use the water? This was followed by drying up of dams and streams leading to irrigated crop failure in the area due to siltation and high temperatures. About 21% of the respondents were also of the view that inadequate water to support large scale farming in general was the challenge facing them. From the foregoing discussion, it's obvious that majority of the participants rated conflict over water use the core challenge facing availability of water in the Nadowli/Kaleo District.

Managerial challenges were also detected in the findings, as presented on Table 4.16.

Table 4.16: Managerial Challenges Facing Irrigation Farming

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Weighted Average	Rank
Destruction of crops by livestock	7	10	2	41	40	3.97	2nd
Lack of ready market for harvested crops	5	15	4	40	36	3.87	3rd
Lack of information on input availability	10	10	10	36	34	3.74	4th
Theft of crops from irrigation farming	8	20	3	35	35	3.72	5th
Pests and diseases	10%	5%		40%	45%	4.05	1st
Perishability of some crops	15	9	6	30	40	3.71	6th

Source: Field Survey, 2022.

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The results revealed that majority of the study participants agreed that the presence of pest and diseases was the most influential factor militating against the irrigation farming by smallholder farmers. This was justified as it was ranked first using the Cumulative Weighted Averages of 4.05. This was followed by destruction of crops by livestock as a factor militating against irrigation farming, rated second with a weighted average of 3.97. The study again found that lack of ready market for harvested crops was ranked third while lack of information on input availability, theft of crops from irrigation farming and perishability of some crops were ranked 4th, 5th and 6th respectively.

However, during focus group discussions with farmers in Sankana, it was disclosed that other challenges that militate against management of irrigation farms included lack of training on modern methods of irrigation farming, lack of improved varieties of seeds such as early maturing crops, lack of financial assistance for increased productivity and low prices of crops among others.

These findings follow the trajectory dictated by the facet of the conceptual framework in Figure 2.2, about challenges of irrigation farming, which were specified as water-related challenges (e.g. drought), input and managerial challenges. The findings also corroborate with the 'shocks' tenet of the Sustainable Livelihoods Framework in Figure 2.1 of this study.

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4.7 Ways of mitigating challenges facing irrigation farmers to improve their livelihood

In the Nadowli/Kaleo District, the small scale irrigation farmers have adopted different strategies of water management towards increasing the efficient use of water. Figure 4.3 shows the various strategies adopted and used by small scale irrigation farmers in the Nadowli/Kaleo District.

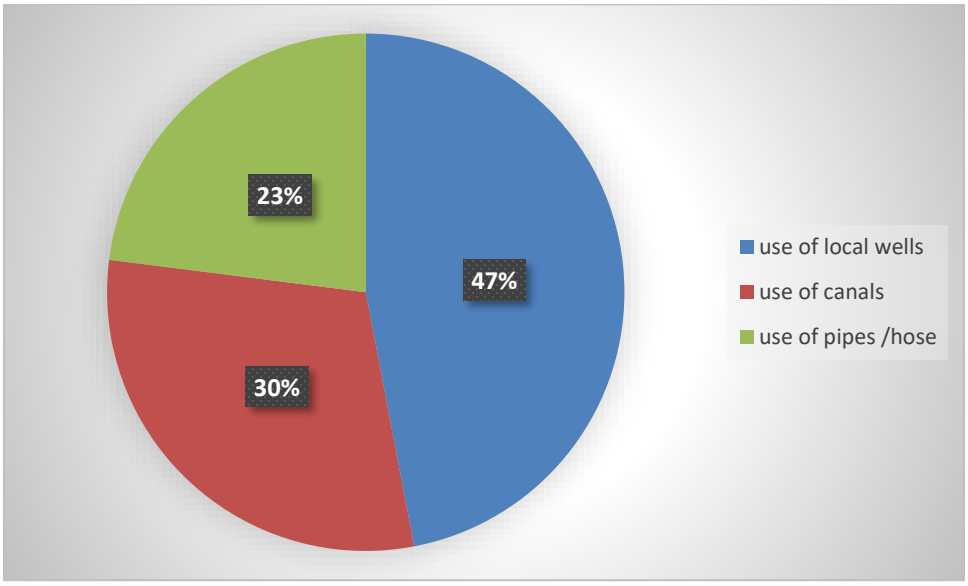

Figure 4.5: Strategies used by Farmers to enhance sustainable Irrigation Farming

Source: Field survey, 2022

As shown in Figure4.5, the various strategies employed and used by small scale irrigation farmers in the Nadowli/Kaleo District include local canals, water hose, pipes and local wells to channel water to their irrigation farms. Many of these irrigation farmers constituting 47% adopt and use local canals to facilitate their irrigation activities whilst 30% of respondents dig and use local wells to be able to

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generate, store and channel water to their various farms to facilitate crop growth. The remaining 23% of respondents adopt and use strategies such as water hose and pipes to channel water from the constructed wells or water sources onto their farms for watering of crops.

However, irrigation farmers also practice sub-surface drip irrigation where the application of high frequency small irrigation volumes is provided below the soil surface and have been increasingly used to enhance irrigation efficiency. It could be seen in the Figure 4.6 and 4.7 respectively that irrigation farmers are adopting to the use of locally constructed canals and long hose to enhance sustainable irrigation.

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Plate 4.1. Locally constructed canals at Nanville small-scale irrigation site

Source: Field Survey, 2022

Plate 4.2. Use of long hose at Kaleo Small-Scale Irrigation Site

Source: Field Survey, February, 2022.

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By exploring the strategies adopted and used by irrigation farmers, the study builds on the works of Zakaria et al. (2015), that most irrigation farmers by way of coping with the inadequacies that exist in accessing the needed irrigation facilities and equipment, farmers use locally constructed canals to channel water to their farms, others use wells where water hose and pipes are connected in order to direct the flow of water to irrigate their farms. The findings reflect the successful application of the bottom row of the conceptual framework in Figure

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2.2, which is about alternative ways of improving livelihoods through irrigation, by identifying the place of policy and programmes, extension services and managerial support.

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CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter encompasses the major findings, conclusion and recommendations reached by the study. The study concentrated on the nature of small holder irrigation farming activities, how irrigation farming affect livelihood of small holder farmers and the challenges as well as ways of mitigating these challenges in the Nadowli/Kaleo District. On the basis of this, the following were the major findings obtained.

5.2 Summary of findings

The subsections below present summaries of the study based on the thematic areas of the objectives.

5.2.1 Nature of irrigation farming

In response to research question one, this study found that the unreliable nature of rainfall, which occurs once a year is the reason why irrigation farming is necessary. Inadequate rainfall exposes farmers to significant risk when seasonal changes and droughts occur, which explains why irrigation farming is necessary in the area. Apart from the socioeconomic characteristics of the participants and

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other conditions of irrigational infrastructure, farmers also have reasons for engaging in irrigation, which include avoiding seasonal unemployment and supplementary income.

5.2.2 Effects of irrigation farming on livelihoods of farmers' households

In consonance with research question two, the results this study revealed statistically significant relationship between the practice of irrigation farming and various variables of livelihood, specifically employment status, income and food security. It was found that household consumption levels increased during engagement in irrigation than before. This is because majority of the respondents used to have meals once a day before participation in irrigation, which increased to twice a day or three times a day after they started practicing irrigation. The main impact of irrigation farming on households was the ability to cater for their health insurance needs.

5.2.3 Challenges of smallholder irrigation farming

In line with research question three, some challenges of smallholder irrigation farming were identified by this study. It was found that irrigation farming among smallholder farmers is hindered by market restrictions, inadequate infrastructure, land and water constraints.

5.3 Conclusions

The findings of this study show conformity to the adopted theoretical and conceptual frameworks. For example drought as a climatic condition of the study

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area is synonymous to shock as stipulated in the Sustainable Livelihoods Framework, while the adoption of irrigation farming as a response to drought corresponds with intention or motivation tenet of the Theory of Planned Behavior.

Furthermore, the socioeconomic characteristics of the participants of smallholder irrigation in the study area, the nature of rainfall, accessibility to land, and types of crops cultivated have measured up to the first component of the conceptual framework of the study to achieve research objective one, which is about the nature of irrigation. The empirical evidences of improvement in household income, food security, employment and other basic necessities such as access to healthcare through ability to pay health insurance premiums, conform to the dictates of the second component of the conceptual framework. It also contributes to the achievement of the second research objective, which is about the effects of irrigation on livelihoods. Challenges such as access to land and the associated disparities by gender, lack of access to information on inputs, inadequate water sources for irrigation and other managerial constrains also correspond with the third component of the conceptual framework, and address the third objective on challenges of irrigation.

Generally, the study results have proven that irrigation farming has experienced policy and programme interventions through the National Irrigation Policy of Ghana and the One-village One-dam programme. However, the study communities have not benefitted much from such interventions, the statistically

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significant nature of the relationships between irrigation and household income, employment and food security signify that interventions to improve irrigation farming could adequately lead to improvement in these livelihood aspects of the study communities in the Nadwoli-Kaleo District of Ghana.

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5.4 Recommendations

Based on the outcome of this study, even though much have been dealt into the issues of small holder irrigation farming and its impact on livelihood it is important to appreciate that, there are other areas that need to be addressed. The study therefore made recommendations for the following;

- ✓ The unreliable nature of rainfall, which occurs once a year is the reason why irrigation farming is necessary. Inadequate rainfall exposes farmers to significant risk when seasonal changes and droughts occur. The Government of Ghana should therefore provide more irrigational facilities in the area by extending the One-vallage One-dam programme to the study communities.
- ✓ In addition, any intervention to improve livelihoods through irrigation would have higher chances of success if targeted at employment, income and food security. Stakeholder interventions, through collaboration between NGOs, Local Government Authorities and GIDA, should therefore focus on motivational strategies to improve youth participation in irrigation by means of award schemes to reduce unemployment; provide

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improved seeds for better yields to revamp food security; and explore avenues for ready markets by linking smallholder producers to agro-based industries that need their products as raw materials.

- ✓ Other challenges that militate against management of irrigation farms included lack of training on modern methods of irrigation farming, lack of improved varieties of seeds such as early maturing crops, lack of financial assistance for increased productivity and low prices of crops among others. The study again recommended that, series of sensitization and educational programmes should be organized to increase knowledge of management in matters relating irrigation. This will go a long way to boost irrigation, increase productivity and better positioned food security and wellbeing.

- ✓ Ghana Irrigation Development Authority (GIDA) should always involve community members in the planning and development of small-scale irrigation dams. Participatory irrigation management has been considered as the driving force in the effective and efficient irrigation management that is by involving small scale irrigation farmers in planning, operation and maintenance of the irrigation schemes.

- ✓ The Nadowli/Kaleo District Assembly through the Government of Ghana should support in the rehabilitation of small scale irrigation dams by constructing new canals, replacing damage pipes and desilting the

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reservoirs. This would reduce waste of water and improve on small-scale irrigation activities in the District.

5.4.1 Suggestions for Further Research

To future researchers, it is recommended that more scientific and collaborative research approach should be employed to extensively study the contributions of irrigation farming to the socio-economic development of urban and peri-urban communities.

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APPENDICES

Appendix 1

A STRUCTURED INTERVIEW GUIDE FOR HOUSEHODS ON THE IMPLICATIONS OF IRRIGATION FARMING ON THE LIVELIHOODS OF SMALL HOLDER FARMER HOUSEHOLDS IN NADOWLI-KALEO DISTRICT

To the Prospective Respondent:

This interview is being conducted to obtain information on the implications of irrigation farming on the livelihoods of smallholder farmer households in Nadowli-Kaleo District. You have been selected because you are in a better position to give responses that would contribute to quality data and report on the subject matter. It is purely for academic purpose and so you are assured of confidentiality of information provided. Your acceptance and willingness to participate in the interview would therefore be highly appreciated.

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SECTION ‘’A’’

BACKGROUND OF RESPONTS

1. Age
   - 15-45 ☐
   - 46-59 ☐
   - 60 and more ☐

2. Sex
   - Male ☐
   - Female ☐

3. Education
   - Basic ☐
   - Secondary ☐
   - Tertiary ☐
   - None Formal ☐
   - None of the Above ☐

4. Community
   - Sankana ☐
   - Kaleo ☐
   - Nanville ☐

5. Monthly income level
   - 100-200
   - 300-400
   - 500 and above

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6. Occupation
   - Farming ☐
   - Trading ☐
   - Local Industry ☐
   - Formal Sector Employment ☐

7. Residential status
   - Native ☐
   - In-Migrant ☐
   - Emigrant ☐

8. Marital status
   - Married ☐
   - Single ☐
   - Widowed ☐

9. Household size
   - 1-3 ☐
   - 4-6 ☐
   - 7 and above ☐

10. Do you practice irrigation farming?
    - Yes ☐
    - No ☐

11. Does your gender influence your participation in irrigation farming?
    - Yes ☐
    - No ☐

12. Does your income determine your participation in irrigation farming?
    - Yes ☐
    - No ☐

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13. Does your marital status determine your participation in irrigation farming?
    - Yes ☐
    - No ☐

14. Does your educational attainment determine your participation in irrigation farming?
    - Yes ☐
    - No ☐

15. Does your resident status determine your participation in irrigation farming?
    - Yes ☐
    - No ☐

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SECTION 'B'

CONDITIONS THAT NECESSITATE IRRIGATION FARMING

16. Does the nature of rainfall in this community determine your participation in irrigation farming?
    - Yes ☐
    - No ☐

17. What is the nature of rainfall in your community?
    - It begins early ☐
    - It begins late ☐
    - It is of shorter duration ☐
    - It is of longer duration ☐
    - The rainfall is adequate ☐
    - The rainfall is inadequate ☐

18. How does the nature of rainfall affect food crop farming?
    - Crops mature adequately within the rainy season ☐
    - The rains end before the crops mature sometimes ☐
    - The rainfall is irregular and affects the development of cops ☐
    - The rainfall does not promote adequate crop yield ☐
    - The rainfall promotes adequate crop yield ☐

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SECTION 'C'

NATURE OF SMALL SCALE IRRIGATION FARMING

19. Do you have irrigation project sites in your community?
    - Yes ☐
    - No ☐

20. Is it easy to acquire a portion of land at the project site?
    - Yes ☐
    - No ☐

21. What are the condition for acquiring land at the irrigation project site?
    - By buying a plot of land ☐
    - By paying annual rent for the use of the land ☐
    - By sharing harvest of irrigation produce with land owner ☐
    - Direct ownership of land at the project site ☐

22. What other factors influence your participation in irrigation faring?
    - Inadequate crop yield during rainy season ☐
    - Diversification of occupation ☐
    - A source of supplementary income ☐
    - To avoid seasonal unemployment ☐
    - Lack of land for farming in the rainy season ☐
    - Others
    - Specify ----------

23. What is the average size of your irrigated land?
    - Less than one acre ☐
    - One acre ☐
    - More than one acre ☐

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24. What is the duration of the irrigation farming period?
- 1-3 ☐
- 4-6 ☐
- 7 and more ☐

25. What crops are cultivated on the irrigated land?
- Vegetables ☐
- Cereals ☐
- Legumes ☐
- Roots and tubers ☐
- Plantation ☐

26. What is the nature of ownership of the irrigation project?
- Government owned ☐
  NGO funded ☐
- Community owned ☐
- Privately owned ☐
- Donated by philanthropist ☐

27. What is the main source of water for the irrigation project?
- Stream/river ☐
- Dam ☐
- Dug-out ☐
- Mechanized borehole ☐
- Borehole with hand pump ☐
- Well ☐
- Reservoir ☐

28. What technology is used for the irrigation of crops?
- Use of canals ☐
- Use of pumps ☐
- Manually ☐

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SECTION 'D'

EFFECTS OF IRRIGATION ON LIVELIHOOD OF SMALL HOLDER HOUSEHOLDS

29. Has irrigation contributed to your employment status?
    - Yes ☐
    - No ☐

30. Compare your income level before engagement and during engagement in irrigation farming?
    - No change ☐
    - It has improved ☐
    - No improvement ☐
    - No income ☐

31. What is the effect of irrigation farming on household food crop output?
    - No change ☐
    - It has increase total food crop output ☐
    - It has reduced total food crop output ☐

32. Comment on the effect of irrigation on household nutrition?
    - It contributes to a variety of food crops consumed by the household ☐
    - It makes the cultivation of vegetables possible for the nutritional needs of the household ☐
    - It has not introduced any variety ☐

33. How many meals was your household taking before your engagement in irrigation farming?
    - Once a day ☐
    - Twice a day ☐
    - Three times a day ☐
    - Four or more ☐

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34. How many meals was your household taking during your engagement in irrigation farming?
    - Once a day ☐
    - Twice a day ☐
    - Three times a day ☐
    - Four or more ☐

35. What other positive effect has irrigation farming brought to your household?
    - Increase ability to pay health insurance premium and meet other health needs ☐
    - Increase ability to cater for household shelter needs ☐
    - Increase ability to cater for clothing of household members ☐

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SECTION 'E'

CHALLENGES OF SMALL HOLDER IRRRIGATION FARMERS

36. Do you have challenges in acquiring inputs?
    - Yes ☐
    - No ☐

37. What are some of the challenges you face in input acquisition?
    - unavailability of the inputs ☐
    - high cost of inputs ☐
    - low quality of inputs ☐
    - lack on education of the right use of inputs ☐
    - lack of capital for the acquisition of the inputs ☐

38. What challenges do you face in the availability of water for irrigation farming?
    - there is inadequate water to support large scale farming ☐
    - the dam or stream sometimes dry out leading to irrigated crop failure ☐
    - there is sometimes conflict over the use of water from the irrigation project with neighbouring communities ☐

39. What managerial challenges do you face with irrigation farming?
    - Lack of training on modern methods of irrigation farming ☐
    - Lack of improved varieties of seeds such as early maturing crops ☐
    - Lack of information on input availability ☐
    - Lack of financial assistance for increased productivity ☐
    - Pests and diseases ☐
    - Destruction of crops by livestock ☐
    - Theft of crops from irrigation farming ☐
    - Lack of ready market for harvested crops ☐
    - Low prices of crops ☐
    - Perishability of some crops ☐

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40. Suggest recommendations of how irrigation farming can be improved?

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Appendix 2

FOCUS GROUP INTERVIEW GUIDE FOR SMALLHOLDER IRRIGATION FARMERS

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 without irrigation?

11) Approximately how much can one earn from irrigation as labour offered?

12) In case 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 households and communities?

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

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?

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……
……
2) When does farmers mostly engage in irrigation farming?

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……

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?

……

……

……

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Appendix 3

IMPLICATION OF IRRIGATION ON THE LIVELIHOOD OF SMALL HOLDER FARMERS IN THE NADOWLI-KALEO DISTRICT OF THE UPPER WEST REGION.

GHANA IRRIGATION DEVELOPMENT AUTHORITY- OFFICIAL

INTERVIEW GUIDE

1. What is your position in the Ghana irrigation development Authority?

2. How long have you been working in this organization?

3. How many irrigation schemes are in the Nadowli-Kaleo district of the Upper West region?
4. What type of irrigation system is found in the Nadowli-Kaleo District? Public/formal surface irrigation system [ ] Non-formal irrigation system [ ]
5. If non-formal irrigation is practiced in the Nadowli-Kaleo District, kindly describe the specific type found there (e.g. small reservoir-based communal irrigation systems)
6. Complete the table below on stakeholders and their roles in irrigation farming

Name of stakeholder	Location of the stakeholder (which district in the region?)	Sector (e.g. public/formal, private/non-formal, communal)	Type of irrigation scheme the stakeholder is associated with	Role of the stakeholder

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7. Assess the effectiveness of the roles of the stakeholders on improving livelihoods of small-holder irrigation farmers in the Nadowli-Kaleo District by completing the table below

8. What is the total number farmers on the irrigation schemes in the district?

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Name of stakeholder	Name and location of irrigation scheme in the NKD	Specific role played	Aspect of livelihood of small-holder irrigation famers impacted	Evidence of effectiveness of the impact of the stakeholder role on the aspect of livelihood (e.g. aspect- income generation; evidence of effectiveness- average income of irrigation farmers is higher than non-irrigation farmers)

9. How many women are involved in irrigation in the district?

10. How significant is irrigation farming in the Nadowli-Kaleo district?

11. What are some the challenges of irrigation confronting irrigation farmers in the district

12. How many irrigation schemes are in the Upper West region?

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13. Do you play in the allocation land to farmers on the schemes in the district?

14. What factors influence a small holder farmers decision to adopt irrigation farming

15. What ways can irrigation be improved in the district?

16. What is the average size of land for an irrigation farmer in the region and in the district?
17. When does irrigation farming start in a year?

18. What time does the irrigation season end?

19. Kindly complete the table below on irrigation schemes in the Nadowli-Kaleo District

    Distribution of types of irrigation schemes

Locality	Type of irrigation system	Type of ownership (public/communal/ etc.)	Number
Entire District		Communal	
Kaleo			
Nanville			
Sankana			

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Total			

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