

**INSTITUTE FOR ENVIRONMENT AND SANITATION STUDIES**

**UNIVERSITY OF GHANA**

**FORMAL AND INFORMAL INSTITUTIONS IN CLIMATE CHANGE  
ADAPTATION: THE CASE OF LAWRA AND NANDOM DISTRICTS IN THE  
UPPER WEST REGION, GHANA**

**BY**

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## DECLARATION

I, RABIATU ABASS, declare that except for references to other people’s work for which I have acknowledged, the work described in this project was performed by me in the Institute for Environment and Sanitation Studies, University of Ghana under the supervision of Dr. Adelina Mensah and Dr. Benedicta Fosu-Mensah.

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## **ABSTRACT**

As the current frequency of climate impacts is expected to increase in semi-arid regions of Ghana, smallholder farmers will require access to new and relevant information to adapt successfully. Institutional support is increasingly gaining attention for effective and successful adaptation; however, there is limited knowledge on the specific roles of both formal and informal organizations in implementing adaptation strategies in semi-arid regions. Using the Lawra and Nandom Districts as case studies, the various roles of existing institutions in adaptation strategies were examined. A total of 135 household questionnaires, six focus group discussions (FGDs), 20 in-depth interviews with farmers, and seven key informant interviews from institutions evaluated climate risks and impacts, adaptation responses of farmers and the functions of the different institutions in supporting these adaptation strategies. The majority of respondents observed irregular and unpredictable rainfall (77%), that high temperature and extreme heat (56%) and rainfall sometimes ceases during growing season (55%) as the main changes in the past 10 years. Major agricultural adaptation strategies identified were changing of planting dates (100%), planting of different varieties of the same crop (51%), planting of trees (35%) and seasonal migration of the local farmers (21%). There is high dependence of the smallholder farmers with formal institutions' resources to adapt, especially for developing/building the local capacity, rather than on local innovations within the communities. This is mainly due to the lack of knowledge about climate change risks and adaptation strategies and limited or no access to financial resources. Government-led adaptation is considered to be more sustained than NGO-led programmes, although the government-led adaptation comparatively lacks specific mandates and financial resources. Continued support of formal institutions will therefore enable the development of more effective agricultural adaptation initiatives.

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## **LIST OF ACRONYMS AND ABBREVIATIONS**

AIL	Adaptation, Institutions and Livelihoods
BVR	Black Volta River
CARE	Cooperative for Assistance and Relief Everywhere
CIKOD	Centre for Indigenous Knowledge and Organisational Development
CSIR	Council for Scientific and Industrial Research
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization
FES	Friedrich-Ebert-Stiftung
FGDs	Focused Group Discussions
GDP	Gross Domestic Product
GEMProject	Ghana Environmental Management Project
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
KNUST	Kwame Nkrumah University of Science and Technology
MEST	Ministry of Environment, Science and Technology
MESTI	Ministry of Environment, Science, Technology and Innovation
MoFA	Ministry of Food and Agriculture
NANDIRDEP	Nandom Deanery Integrated Rural Development Program
NGOs	Non-Governmental Organizations
NHIS	National Health Insurance Scheme
OECD	Organisation for Economic Co-operation and Development
SARI	Savanna Agricultural Research Institute
SEI	Stockholm Environment Institute
SRI	Soil Research Institute

UDS	University of Developmental Studies
UG	University of Ghana
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VSLA	Village Savings and Loan Association
WMO	World Meteorological Organisation
WRI	Water Research Institute

## CHAPTER ONE

### BACKGROUND OF STUDY

Increasing global warming has led to a change in the magnitude and frequency of some extreme weather events in sub-Saharan Africa that has impacted on its social and economic development (IPCC, 2014). These countries are more vulnerable due to their high dependence on climate sensitive sectors which reduces their capacity to adequately adapt to the changing climate (Nordhaus, 1991; Stern, 2006; Akram and Hamid, 2015). The agricultural sector employs the majority of the rural population and as a result has the potential to exacerbate their vulnerabilities as their "... livelihoods depend on already overstrained climate-sensitive resources and their social welfare systems are weak" (Chalise and Naranpanwa, 2016:1). Recent reductions in agricultural production in these regions have been attributed to late rains, increased drought, and decreased soil fertility among, others (Yengoh *et al.*, 2010; Stanturf *et al.*, 2011). This situation is likely to worsen under future climate change as adaptation by the local community is restricted as a consequence of increasing poverty (Nelson and Agbey, 2005).

According to IISD, IUCN and SEI (2003), addressing future climate change impacts will need to be based on collaboration and adaptive capacity of society and the country at large, which must be locally initiated by the people and supported by the government and other institutions. The successful implementation of adaptation strategies therefore requires both local and national mandates (Corfee-Morlot *et al.*, 2009). National mandates are critical in ensuring the implementation of climate change adaptation as they mobilize political will, support research institutions, establish networks that promote information sharing and also facilitate and finance mechanisms (Noble *et al.*, 2014). On the other hand, local mandates foster intergovernmental coordination and facilitate the implementation of climate change adaptation through individual and collective actions at all levels (Agrawal and Perrin,

2008; Noble *et al.*, 2014). As a result, national policies and development projects must reflect the local communities' interests and experiences in order to effectively assist communities' full potential to engage in a successful climate change adaptation (Savane, 2013; Komba and Muchapondwa, 2015). Thus, for successful adaptation strategies targeted towards smallholder farmers, the compliance and devotion of formal and informal institutions at local, regional, national and global actors are indispensable.

### **Problem Statement**

Reduction of Gross Domestic Product (GDP) in the agriculture sector observed in recent years in Ghana is ascribed to the negative impacts of climate variability/change on the agricultural produce (GNCCP, 2012).

Poverty in Ghana is polarized to the rural areas (UNDP, 2013), especially in the savannah ecological zones of the Upper East and Upper West Regions of the country. The Lawra and Nandom Districts have been recognized to have unsustainable land management practices relating to poor soil organic matter management in addition to increased deforestation and bush burning which contributes to drought risks and high soil temperatures in the area (Padgham *et al.*, 2015). This situation is likely to worsen under future climate change as adaptation by the local farmers is restricted as a result of increasing poverty. Thus, their ability to effectively adapt to the changing climate will be incapacitated (Nelson and Agbey, 2005).

The success of effective implementation of agricultural climate change adaptation in this region depends on the connected efforts of decision makers in institutions (formal and informal) to ensure equitable access to their resources. This is to reduce climate risks through the reinforcement of adaptive capacity of the rural poor in the communities. This is to better augment policy formulation of institutions under agricultural climate change

adaptation in this region.

### **Rationale**

The rationale behind this research is examining the relevance of the implementation of agricultural activities as means of adaptation under climate change among smallholder farmers in the Upper West region of Ghana by institutions (formal and informal).

Despite the fact that farmers in developing countries have “...demonstrated considerable ability to adapt to uncertain climate,” their ability to adapt to future climates will depend on the support they receive from institutions (Challinor *et al.*, 2007). Even though community-based approaches to climate change adaptation implemented in the Upper West, Upper East and Northern Regions of Ghana looks promising, future climate change impacts will need external interventions from government institutions and NGOs for efficiency and sustainability. In this regard, the Africa Adaptation Programme in Ghana focused on the promotion of a holistic and integrated approach to climate change adaptation (Sova *et al.*, 2014). Thus, there is a need to investigate into institutions (formal and informal) efforts, achievements and challenges in implementing climate change agricultural adaptation strategies.

### **Proposition**

The research is based on the proposition that the implementation of climate change agricultural adaptation strategies requires concerted efforts of decision makers in various institutions.

## **Research Questions**

The research seeks to find answers to these questions;

1. What are the observed changes in the weather/climate in the last 10 years by the farmers in the communities?
2. How do people respond to climate change/climate variability and what influences their decisions?
3. What are the institutions in the community and the roles they play towards implementing climate change adaptation?
4. How do the institutional roles impact on the livelihoods of smallholder farmers in the communities?
5. What are the barriers and enablers for these institutions in implementing agricultural adaptation strategies?

## **Objectives of the Study**

The overall goal of the study is to assess how formal and informal institutions support the implementation of agricultural adaptation strategies for smallholder farmers in the Lawra and Nandom Districts of Upper West Region of Ghana.

The specific objectives are:

1. To observe changes in the weather/climate in the last 10 years within the communities
2. To identify types of adaptation strategies and their impacts on smallholder farmers in Lawra and Nandom Districts.
3. To examine the existing formal and informal institutions and their roles in implementing adaptation strategies among smallholder farmers.

4. To examine the challenges institutions encounter in the implementation of the adaptation strategies and highlight useful lessons born out of the experiences of the institutions.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **Climate variability and climate change**

There are a number of definitions for climate variability by different organizations and institutions. One definition is “deviations of climate statistics over a given period (such as during a specific month, season or year) from the long-term climate statistics relating to the corresponding calendar period” (FAO, 2008: Annex II). Another definition is “variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events” (IPCC, 2014). In this instance, variability is seen as variations as a result of either natural or human causes. However, climate variability is considered as the change in the atmospheric composition that is as a result of only natural causes whilst climate change is the human cause of atmospheric change (UNFCCC, 2011).

On the other hand, climate change defined as “a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (decades) (IPCC, 2007: 2). It is a “change that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and is in addition to the natural climate variability observed over comparable time periods” (UNFCCC, 2011: 2). In 2011, the IPCC discovered a new definition for climate change which was precise on the causal agents. That is, ‘climate change may be due to natural internal processes or external forces or persistent anthropogenic changes in the composition of the atmosphere or in land use’ (Corner, 2013).

The major difference between climate change and climate variability is the duration (that is, long term or short term). Climate change is also referred to as the long term (decades or



longer) trends in climate averages such as the global warming and variability in the frequency, severity and duration of extreme events, whereas climate variability influence societies in arid and semi-arid areas, where rainfall patterns are observed to be short with destructive floods (CSIRO, 2010). According to Agrawal et al. (2009), semi-arid regions under climate change will experience higher levels of land degradation and variability of rain and temperature changes. They added that, changes in the temperature and precipitation variability will impact on agriculture-based livelihoods of arid and semi-arid regions of the world. In addition, efforts geared towards climate change agricultural adaptation will require technological inputs as well as institutional adjustments. In Africa, the variations in temperature have led to a pronounced warming trend since 1960. These trends, though consistent over the continent, are not always uniform. Unlike the observed changes in temperature, that of precipitation over the continent is complicated (Boko *et al.*, 2007). This could be attributed to the fact that rainfall exhibits notable spatial and temporal variability (Hulme *et al.*, 2005).

The climatic data of Ghana observed a rise in temperatures and unpredictable rainfall pattern across all ecological zones from 1961 to 2000, signifying the country is already experiencing climate variability/change (MEST, 2010; Asante and Amuakwa-Mensah, 2014: 83). Stanturf and colleagues in 2011 reported an increase in the mean average temperature from 0.21°C/decade to 1.0°C/decade since 1960 in the country which had the greatest change in the northern part of the country with the 1970s and 1980s being drier than average (Musah, 2013). In addition, the annual rainfall is seen to vary on the inter-annual and inter-decadal time scales, which makes the identification of long-term trends difficult. Furthermore, low levels of rainfall patterns were observed in the country between the late 1970s and early 1980s as compared to the high annual rainfall recorded during the 1960s. Thus, an average rainfall of 2.33 mm/month (2.4%)/decade discerned from 1960 to

2006 caused an adverse effect across the whole country (McSweeney *et al.*, 2010; Stanturf, 2011). According to Musah (2013), the climate data on rainfall shows that, the years from 2007 to 2009 were wet years with increasing number of rainy days at a rate of 0.26 days per years. This is evident as the “rainfall during the period 1968-1997 has been on average some 15-40% lower than during the period 1931-1960” (Nicholson *et al.*, 1999; Yaro *et al.*, 2015: 3). It added that, there has been a divergent view on the future scenarios on rainfall in West Africa. Studies from Minia (2004) projected a decrease in the annual rainfall in West Africa whilst Samuel Nii, (2010) among other studies also projected an increase in the annual rainfall.

### **Climate change impacts on agriculture**

Climate change impacts negatively affects the basic elements of food production such as water, soil and biodiversity (FAO, 2009). Hence, smallholder farmers modify their agricultural practices to adapt to the changing climate (Etwire, 2013).

### Water Resources

The provision of water for human and environmental needs is crucial for policy deliberation in many countries including Ghana. However, the balance between human water use and environmental stewardship is barely achieved due to the impact of climate change. The water sector in general is highly sensitive and it is influenced by the changes in climate. Climate change comes with great challenges for water management in Ghana and certainly, adaptation and innovative management will be a necessary response. For instance, changes in precipitation as well as temperature will affect the hydrologic cycle which will have a contrary impact on the quality and quantity of water resources (Miller and Yates, 2006). The quality of freshwater in rivers and other water bodies will also be impacted negatively as the expected increased floods would carry pollutants into water

bodies, restricting their use and putting further constraint on water availability to meet growing demand. This also impacts on the water available to soils among others (Cunha *et al.*, 2005). The situation of water stress will be worsened in arid and semi-arid regions as periodic and chronic drought will be rampant (Lemmen and Warren, 2004). Consequently, an increase in population will result in a high demand for water. The observed variations in rainfall and runoff make the water resources very sensitive with climate change which requires immediate implementation of adaptation measures (for example IPCC, 1997).

Studies at CSIR-WRI show that even without climate change considerations, Ghana is predicted to become a water stressed country by 2025. According to the CSIR-WRI report in 2000 on climate change and water resources estimates; a general reduction in annual river flows in Ghana by 15-20 % for the year 2020 and 30-40% for the year 2050; a reduction in groundwater recharge of 5-22% for 2020 and 30-40% for 2050; an increased irrigation water demand of 40-150% for 2020 and 150-1200% for 2050; a reduction in hydropower generation of 60% for 2020 and; by the year 2020, all river basins will be vulnerable and the whole country will face acute water shortage (Kankam-Yeboah *et al.*, 2010).

In the face of increases in the frequency and severity of extreme weather events in the future, it is most likely that climate change will worsen future water scarcity in many places in the country. Frequent floods have the potential to wreak havoc on expensive water infrastructures for domestic water supply, irrigation and hydropower generation. Since climate change is inevitable, there is the need for adaptive strategy that will build resilience to water, food, health and energy (Mwenge, 2007).

## Soils

Soils are essential component in agricultural production. However, the rate of soil degradation and erosion threatens both agriculture productivity and environmental sustainability (Verbruggen and Laes, 2015). Low soil fertility is usually frequent in Africa especially in the semi-arid regions. This has been attributed to high rate of leaching, weathering and poor soil management (Okalebo *et al.*, 2006). Furthermore, the observed high temperatures and low rainfall among others resulted in moisture scarcity in the soils which impedes on the quality and quantity of crop production in these regions (Tadele, 2017). Increased drought owing to climate change is expected to reduce crop yields by 50% in semi-arid regions of Africa. Clair *et al.* (2009), confirmed that excess precipitation and drought inhibits the growth of soil bacteria responsible for nitrogen cycle thus, resulting in the possible leaching of nitrate from the soil. This is manifested in the varieties of crops such as cowpea and bambara groundnut (Olivia and Olitina, 2014) cultivated in these regions.

Partial rainfall in the year and extensive drought conditions in some parts of the year result in a shallow type of soils in the area which covers the impermeable ironpan (ironpan soils). Majority of such soils have been classified locally as Groundwater Laterites (which may be Petrosols). These are the most extensive soils occurring within the Sudan and Guinea Savanna Group (SGSG) belt. Savannah Ochrosols, Savannah Ochrosol-Groundwater Laterites Intergrades, Savannah Ochrosol-Rubrisol Intergrades, Savannah Lithosols, Tropical Black and Brown Clays, Savannah Gleisols, Savannah Gleisol-Tropical Black Clay Intergrades and Savannah Gleisol-Alluviosol Intergrades, all of which, except ironpan soils (Petrosols), Savannah Ochrosol-Groundwater Laterites, Savannah Ochrosol-Rubrisol Intergrades, Savannah Gleisol-Tropical Black Clay Intergrades and Savannah Gleisol-Alluviosol Intergrades are other major soils within the belt (Obeng, 2000).

Soils form part of the carbon (C) and nitrogen (N) cycles which form the major components of organic matter. Changes in temperature and rainfall as a result of climate change will influence soil organic matter which will affect agriculture production (Brevik, 2013). For instance, increase in temperature is likely to have a negative effect on C in the soils which will affect organic component of the soil. A study of soils in semi-arid steppe on soil warming and drying led to a 32% reduction in soil carbon over a five year time period, a much more rapid reduction in soil C than reductions that have been observed due to increased tillage (Link *et al.*, 2003). With potential degradation of soils in developing countries under climate change, there is a need for a collective and effective approach towards soil management through climate change adaptation.

#### Pests and diseases

The impact of climate change is predicted to share a complex relationship with pest and diseases in Africa. The ideal temperature and humid conditions in Africa provides a conducive environment for the outbreak of pests and diseases. This is responsible for the observed reduction in crop production across the continent recently (Goldman, 1996; Tadele, 2017). Dipterous and lepidopterous stem borers are the main pests together with a wide range of fungal, bacterial and viral diseases are highly prevalent on the continent (Tadele, 2017).

The incidence of crop pests and diseases in the north of Ghana is usually low during the 2001 season except for the outbreak of armyworms in Bawku East and Bawku West Districts of Upper East Region around May and June. There were significant loses as affected area was estimated around 1500 ha of millet and maize. Additionally, there have been frequent reports of stored groundnut being attacked by a pest in the Upper West

Region. Storage pests of cowpea are also common in northern Ghana which contributes to agriculture losses in the country (FAO, 2002).

To minimize the threat of these pests and diseases in the context of climate change, an integrated approach between farmers and external agencies has to be established (for example, Chakraborty and Newton, 2011).

### **Impacts of climate change on agricultural livelihoods**

Developing countries particularly Ghana, depend on agriculture, a climate sensitive economic sector for livelihoods. This sector is very vulnerable to the impacts of climate change because of the inability of the poor farmers to efficiently adapt to the changing climate (Brukner, 2012). Climate change impacts will affect the overstrained communities and the rural poor in developing countries (FAO, 2008). These communities are often characterized by poor smallholder farmers with minimal livelihood alternatives and largely depend on nature for food and income (Frank and Penrose-Buckley, 2012). For example more than 80% of the global agriculture land is rain-fed with less than 1% of its arable land under irrigation scheme in Ghana (World DataBank, 2013; Wood, 2013). This is attributed to the fact that irrigation options and resources are beyond the reach of the farmers (Stanturf *et al.*, 2011). Additionally, the three Northern regions in Ghana are the leading producers of cereals. However, rainfall variations together with inadequate irrigational system has led to an abrupt decrease in the average yield from 1200 kg in 1996 to less than 900 kg in 2000 (Brimoh and Vlek, 2006; Stantfur *et al.*, 2011).

Temperature is one of the major factors that affect agricultural production. Higher temperatures and low rainfall ascribed to climate change will have negative impacts on agriculture in semi-arid regions (Antle, 2008) as it leads to reduce crop productivity in agriculture-based economies. This poses great risks on the livelihoods of the people (Hummel, 2015; Gameda and Sima, 2015). In Africa, an increase of 2°C in temperature

and a corresponding water stress due to climate change will result in a significant loss of crop (Fischer *et al.*, 2005; Lotze-Campen, 2011). Similarly, if Ghana is projected to experience higher temperatures within the period of 2010-2050 which will lead to about 35% of the landmass (20,000 ha/yr) lost to deserts in the country (Asante and Amuakwa-Mensah, 2014) agriculture production in some parts of the country will be at a halt.

The effect of climate change complements the existing pressure on global agriculture system that struggles to respond to the demand of growing population (OECD, 2015). A similar trend is observed in Ghana where the variations in the weather patterns over the years made the cultivation of crops a major issue of concern among the farmers affecting the total outputs and income to the country (Tully, 2012). The effect of climate change on agriculture fundamentally depends on the possibility to adapt to climate change impacts (Lobell, 2014).

### **Climate change adaptation**

Adaptation is considered as the main strategy for reducing the negative impacts of climate change. It is the most proficient way for farmers to reduce these climate change impacts on agricultural produce (Fussler *et al.*, 2006; Bishaw *et al.*, 2013; Komba and Muchapondw, 2015). According to IPCC (2011; 72), adaptation is “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities”. Similarly, adaptation is “adjustments in ecological-social-economic systems in response to actual or expected climatic stimuli, their effects or impacts” (Smit *et al.*, 2000: 225). Moreover, this research employs the definition of adaptation by Moser and Ekstrom (2010:1) as “changes in social-ecological systems in response to actual and expected impacts of climate change in the context of with non-climatic changes.” Adaptation strategies range from short-term to longer-term, with the intention of meeting more than just climate change impacts.

Adaptation is considered as activities throughout a society by individuals, groups and governments (Adger et al., 2005). However, adaptation strategies are not practiced or assessed in isolation from other decisions but in the context of demographic, social interventions and global governance (O'Brien and Leichenko, 2000; Adger *et al.*, 2005). Farmers from developing countries have been coping with droughts, floods and rainfall fluctuations before the advent of climate change (Reid *et al.*, 2013). For instance, north-east Ghana is characterised by frequent droughts and floods which adversely affect farming, the primary source of livelihood for majority of households in the region. Faced with increasing incidence of climate-related shocks and stresses, farmers in the region have always adopted to permanent and seasonal migrations, new crop varieties and irrigation practices (Tambo, 2016). Science has proven that the changes in the global climate will worsen if measures are not put in place to curb the emission from greenhouse (Adger, 2005). Hence, planned adaptation is mandatory in the most vulnerable part of the world like Africa (Bishaw *et al.*, 2013).

IPCC (2001) identifies two types of adaptation strategies based on intent as (i) planned and (ii) autonomous adaptation. Planned adaptation “is the result of a deliberate policy decision on the part of a public agency based on an awareness that conditions are about to change or have changed and that actions are required to minimize losses or benefit from opportunities (Pittock and Jones, 2000; IPCC, 2000: Annex B). It is also defined as “the increase in adaptive capacity by mobilizing institutions and policies to establish or strengthen conditions favourable for effective adaptation and investment in new technologies and infrastructure” (IPCC, 2007: 294). For example, in order to reduce climate change risks, farmers in northern Ghana engage in intercropping with different crop types and the use of short duration crop varieties, use of drought tolerant and early maturing crop varieties (Dietz *et al.*, 2004; Tonah, 1993; Adusei, 2016).



Conversely, autonomous adaptation involves “changes that systems will undergo in response to changing climate irrespective of any policy, plan or decision” (OECD, 2006: 8). Autonomous adaptations are “initiatives by private actors rather than governments usually triggered by market or welfare changes induced by actual or anticipated climate change (Leary, 1999; IPCC, 2001: 7). Due to market failures and constraints with respect to information and resources flow among others, autonomous adaptation will require governments’ intervention in order to achieve optimal adaptation results (Malik *et al.*, 2010). Changing of planting dates, diversification of livelihoods and livestock farming, changing of planting dates and migration are some autonomous adaptation strategies adopted by farmers in developing countries particularly Ghana.

Successful adaptation is dependent on society’s acceptance and familiarity of its intricacies. Countries with mutual political cultures and strong democratic systems are more successful in dealing with environmental problems (Lafferty and Meadowcroft, 2000; Duit, 2008). Access to social and institutional networks at various scales forms an integral aspect of successful adaptation (Tompkins and Adger, 2004; Smit and Wandel, 2006; Pelling and High, 2005; Ford and Smit, 2004; Juhola and Westerhoff, 2011). For adaptation strategies to be successful among smallholder farmers, cooperation and dedication of actors from the local, regional, national and global levels must be included (Komba and Muchapondw, 2015). Adaptation strategies should be based on wealth, controllability and adaptive capacity of that society and the country at large. It must be locally initiated by the people and supported by the government and other institutions (IUCN and SEI, 2003). Adaptation strategies vary greatly depending on the institution responsible which correspond with private and public adaptation. In other studies, Komba and Muchapondw (2015), established that successful adaptation measures requires a

collective response of adaptive action from individual smallholder farmers as well as government policies.

### **Implementation of climate change adaptation strategies by institutions**

Agriculture is the source of livelihood for majority of the populace in Ghana. This provides a better reason for the country's position in agricultural adaptation strategies towards national development. This considers development in the national development plan, based on agriculture and defined in terms of poverty reduction and economic growth (Sarpong and Anyidoho, 2012). The government of Ghana acknowledges the socio-economic impacts of climate change and hence staunch to mainstream it into policies and sectoral activities to achieve sustainable growth (GNCCP, 2012). According to Yaro *et al.* (2014), the formal institutional structure in Ghana, is based on a multi-level government and policies. The policy is coordinated by the Environment and Natural Resources Advisory Council (ENRAC) which operates at Cabinet level within the ministries. The Environmental Protection Agency which sits within the Ministry of Environment, Sciences, Technology and Innovation (MESTI) is responsible for developing national climate change policy and integrating priorities into sectoral plans (Stanturf *et al.*, 2011; Darko and Atazona, 2013:14). Climate change is also being mainstreamed into Ghana's Shared Growth and Development Agenda. In this regards, the country formed the National Climate Change Policy (NCCP) to ensure resilient and climate compatible economy while achieving sustainable development through equitable low carbon economic growth for Ghana. This was an integrated response to climate change in the context of national sustainable development priorities. It also provides a clear pathway for dealing with the challenges of climate change implementation. The country has also established platforms such as the Ghana Climate Adaptation Network (G-CAN) and the Ghana Climate Change Agriculture and Food Security Platform to promote climate change advocacy and integration in to development planning. In addition, the African Adaptation Programme in

the country Ghana provides a holistic and integrated approach to climate change adaptation at the national and sub national development process. This programme is headed by the Environmental Protection Agency (EPA) under the supervision of the Ministry of Environment, Science, Technology and Innovation (MESTI). In 2012, Ghana developed the National Climate Change Adaptation Strategy (NCCAS) to outline a multisector adaptation strategy.

Despite all these facts, the ability of farmers to efficiently adapt to the impacts of climate change is constrained by inadequate income, lack of expertise and inappropriate public policies (Bishaw *et al.*, 2013). Thus, for successful adaptation strategies targeted towards smallholder farmers, the compliance and devotion - of formal and informal institutions - at local, regional, national and global actors are indispensable. According to Eriksen and Brown (2011), adaptation is about the interaction between institutions. That is local strategies and governmental policies that are in support of a particular strategy over the others. Institutions are “rules and conventions of society that facilitate coordination among people regarding their behaviour” (Bromley, 1989: 22). They are norms or strategies that create incentives for behaviour in repetitive situations. For the purpose of this study, institutions are classified as “durable systems of established and embedded social rules that structure social interactions, rather than rules” (Hodgson, 2006: 13). In addition, ‘...formal and informal institutions at the local, regional, and national level can develop the capacity to anticipate and prepare for climate-related risks’ (Savane, 2013). Regional and local level decisions are effective design and implementation of mitigation and adaptation strategies. Even though adaptation may be guided through national led mandates, its implementation is expected to be locally based (Corfee-Morlot *et al.*, 2009).

## **Conceptual Framework**

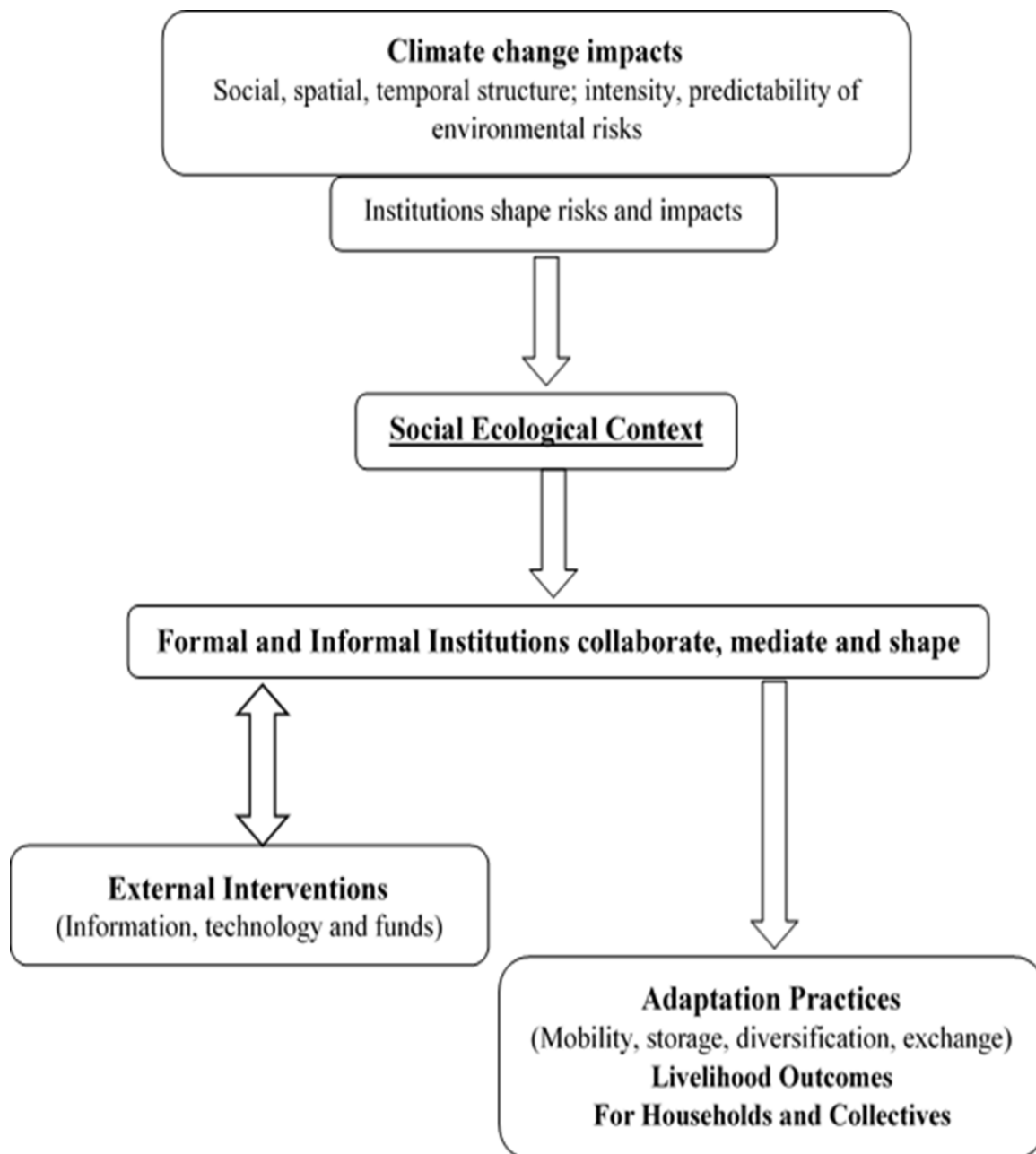
The conceptual framework of this study is based on the implementation of adaptation strategies to address the impacts of climate change and variability among farmers influenced by both formal and informal institutions. It develops the argument on the role of institutions in facilitating adaptation using the Adaptation Institutions and Livelihoods (AIL) Framework as proposed by Agrawal (2008). Most scholars believe that prior knowledge about the climate is necessary for assessing future climate risks. Previous experience and knowledge of adaptation strategies provide strategic lessons for planning current and future adaptation approaches (IPCC, 2007). Past experiences with climate variability may be insufficient in future dealings with climate change impacts (Lebel, 2013).

The AIL framework presents the central role of institutions in the implementation of climate change adaptation. The framework was modified in this research to incorporate the two types of institutions as formal and informal institutions and is placed and context-specific to climate change adaptation. The conceptual framework establishes how institutions structure climate change impacts on households within the social and ecological settings and outlines the degree to which household respond to these impacts either collectively or individually. The climate change impacts from the framework indicate the effects of climate change on natural and human systems across space and time (IPCC, 2007). The social ecological context shows the complex interaction between the human and the natural systems which will be impacted by the changing climate (Folke *et al.*, 2005).

Institutions within this framework, structure environmental risks and vulnerability in order to shape the responses by the rural communities. Equitable access to the institutions and their resources is likely to reduce the negative impacts of climate risks in a community

(Agrawal *et al.*, 2009). Institutions create the incentive framework within which outcomes of individual and collective action unfold. It is within such incentive frameworks that household and community chose specific adaptation practice. The institutions also serve as media through which external interventions get to the local communities. These interventions reinforce or undermine existing adaptation practices. It is clear within this context, why households and collectives opt for one type of adaptation practice over another since external interventions reinforce the adaptive capacity of the rural poor (Wang *et al.*, 2016).

Formal and informal institutions work in a way to promote local initiatives which are critical to climate risk adaptation. These institutions, even though perform different functions, partner to promote cross-domain collaborations. It is convincing to believe that such interactions/collaborations between and among institutions prove extremely important in addressing climate risks adaptation across scales. In such collaboration, each type of institution may be able to overcome the weaknesses of the other. Thus, the success of the institutions will depend on the common understanding/perception about an environmental problem in order to achieve adaptation-related goals.



**Figure 1: Climate Change Adaptation, Institutions and Livelihoods (AIL) Framework**

Source: Modified; Agrawal (2008)

It is clear from these assertions that, adaptation to climate change will require the concerted efforts of decision makers in diverse institutions across multiple scales.

## CHAPTER THREE

### MATERIALS AND METHODS

#### Study Area

##### 3.1.1 Lawra and Nandom

Lawra District (Figure 2) is one of the nine Districts that make up the Upper West Region which derives legal existence from Legislative Instrument (LI) 1434 of 1988. The Lawra District is bounded to the East and South by the Jirapa/Lambussie District and Lambussie-Karni District respectively. The total land area of the district is estimated at 18,476 square km with 157 communities which led to the splitting of the Nandom District from Lawra District in 2012. The district has 95% of its inhabitants in the rural areas.

The Nandom district is one of the eleven districts that make up the Upper West Region. The region was carved from the Lawra district. Nandom District is bounded to the East and South by Lambussie and Jirapa respectively and to the North and West by the Republic of Burkina Faso. The District has a total area of 567.6 square km which has 86% of its inhabitants living in rural areas.

The Nandom and Lawra Districts have a decentralized governance system which is supportive of the traditional governance system in the community (GSS, 2010). The two governance systems complement each other as a team towards achieving the common goal of development.

#### *Relief and drainage*

The topography of the Districts is described as gently undulating with few isolated hills ranging between 180 metres and 300 metres above sea level. The only natural water bodies are the interconnected streams into the Black Volta. The Black Volta has several

tributaries such as the Kamba/Dangbang, Nawer and Duodaa among others. There are however dams and dugout which serve as alternative sources of water for the people.

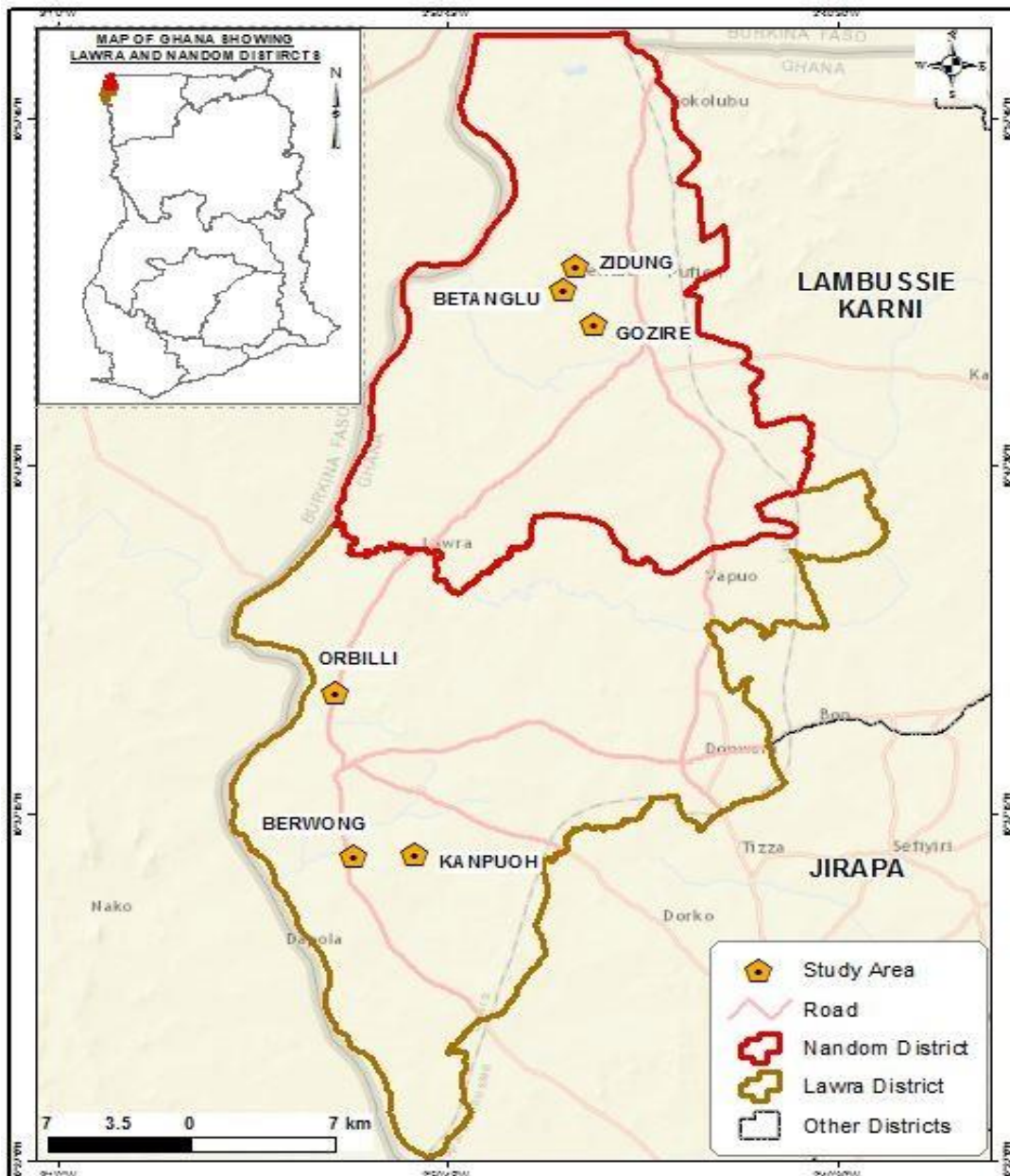
### *Vegetation and Climate*

The districts fall within the Guinea savanna vegetation belt. The vegetation consists of grasses and fire resistant trees such as Baobab (*Adansonia digitata*) and Shea trees (*Vitellaria paradoxa*) and other trees such as mango (*Mangifera indica*) and cashew trees (*Anacardium occidentale*). The districts experience the tropical continental climate like other Northern regions of Ghana with mean monthly temperature between 21°C and 32°C. Single maximum rainfall season prevails from May to September/October and February to April being the hottest.

### *Soils*

Soils in the Upper West region are formed over the Cape Coast Granite. The patterns noticed within the granite areas are very complex. Extensive patches of the upland soils developed either over biotite schist with pegmatite intrusions or over basic gneiss. The gneiss are of red, brown and dark grey clay soils are referred to as the Wa series or Savanna Ochrosol- Rubrisol intergrade. These soils have good moisture retaining capacity and considerable nutrient reserves, thus essential for agricultural practices in the country. Cultivation of cereals and root tuber crops are suitable in these areas due to the soil type. There are however strips of alluvial soils along the flood plains of the Black Volta River.





**Figure 2: Map of sampled communities within the Lawra and Nandom Districts of Upper West region of Ghana**

Source: RS/GIS Lab: Department of Geography and Resource Development (UG)

## Pest

The crop pests and diseases noticed in the Upper West region destroy crops on farm and off farm are summarized in Table 1.

**Table 1: Crop type and their respective pests and diseases**

Type of Crop	Pest/Disease Infestation
Maize ( <i>Zea mays</i> )	Pest: Lepidopterous stem borers; <i>Sesamia botanephaga</i> , <i>S. calamistis</i> , <i>Eldana saccharina</i> and <i>Busseola fusca</i> . Lesion nematode
Sorghum ( <i>Sorghum vulgare</i> )	Pests: stem borers, shoot flies and sorghum midge
Rice ( <i>Oryza sativa</i> )	Pest: white tip nematode, Lepidopterous stem borers; <i>Chilo sp</i> , <i>Sesamia sp</i> , and <i>Maliarpha separatellia</i> Diseases: <i>Helminthosporium oryzae</i> and false smut ( <i>Ustilaginoidea cirens</i> )
Yams ( <i>Discorea spp.</i> )	Pest: Yam tuber beetle ( <i>Heteroligus meles</i> ) and termites Disease: Tar Spot disease
Groundnut ( <i>Arachis hypogaea</i> )	Disease: Groundnut rosette virus disease Rust disease

## **Research Methodology**

The methodology applied in any research has a significant influence on the validity of the findings (Bryman, 2012). This research employed both the primary and secondary sources of data collection. Primary sources of data utilized were key informant interviews, focus group discussions (FGDs) and household and institutional level questionnaire surveys. Secondary sources of data included books, journals, articles and internet that were consulted during the research preparation and literature review phase. The general research questions and the instruments that were used to acquire the data and the analysis are shown in Table 2.

<b>Research objectives</b>	<b>Research questions</b>	<b>Methods</b>	<b>Data processing method</b>	<b>Expected output</b>
1. To identify the types of adaptation strategies and their impacts on smallholder farmers in Lawra/Nandom districts	What are the observed changes in the weather/climate in the last 10 years by the community?	<ul style="list-style-type: none"> <li>• FGDs</li> <li>• Interviews</li> </ul>	Discourse analysis/frequency tables	Observed changes in weather/climate by the people in the last 10years
	How do people respond to climate change/ climate variability and what influenced their decision?	<ul style="list-style-type: none"> <li>• FGDs</li> <li>• Interviews</li> <li>• Questionnaires</li> </ul>	Discourse analysis/ SPSS (pie charts)/frequency tables	<p>Activities as a result of CV/CC</p> <p>Factors that influence their decision</p>
2. To examine the existing formal and informal institutions and their roles in implementing adaptation strategies among smallholder farmers.	What are the institutions present in the community?	<ul style="list-style-type: none"> <li>• FGDs</li> <li>• Interviews</li> <li>• Questionnaires</li> </ul>	Discourse analysis/ SPSS (pie charts)/frequency tables	Existing formal and informal institutions
	What are the roles that institutions play towards climate change adaptation?	<ul style="list-style-type: none"> <li>• FGDs</li> <li>• Interviews</li> <li>• Questionnaires</li> </ul>	Discourse analysis/ SPSS (pie charts)/frequency tables	<p>Roles of institutions in climate change adaptation</p> <p>Activities as a result of CV/CC</p> <p>Factors that influence their decision</p>

<b>Research objectives</b>	<b>Research questions</b>	<b>Methods</b>	<b>Data processing method</b>	<b>Expected output</b>
3. To examine the challenges institutions encounter in the implementation of the adaptation strategies and highlight useful lessons born out of the experiences of the institutions	What are the achievements of these institutions?	<ul style="list-style-type: none"> <li>• FGDs</li> <li>• Interviews</li> <li>• Questionnaires</li> </ul>	Discourse analysis/ SPSS (pie charts)/frequency tables	Successes, Challenges and Way forward.

## **Sampling Design and Technique**

These surveys assessed perceptions about climate change, adaptation strategies and the roles of institutions in the implementation of adaptation strategies. Three communities each from Lawra and Nandom districts were enrolled into the study by stratified sampling.

Stratified sampling was used to select three communities each from Lawra (Orbilli , Kanpuoh and Berwong) and Nandom (Goziire, Zidung and Betanglu) districts. Four of the communities (Kanpuoh, Orbilli, Zidung and Goziire) selected employ various adaptation strategies on their farms whilst the other two communities were with no planned initiative (Berwong and Betanglu). The selection criteria enabled a comparative analysis of the implementation of climate change adaptation strategies among communities and between the two districts.

In each community, households that partook in the study were randomly selected to minimize bias. A sampling frame was derived from the population of each community selected (Table 3). This ensured a representative coverage of the community. The same method was used to select a single household in buildings with more than one household. The use of this method gave all households the fair chance of being selected. In each household, both male and female adults were interviewed. However, preference was given to respondents who have stayed in the community for at least 10 years. This category of respondents could account for the observed changes in the climate of the area as well as the types of adaptation strategies that the individual and /community has been engaged in over the years.

**Table 3: Population size and sampling frame**

Community	Population (N)	Sample size	Sampling frame (n/N)	One-on-one interview (farmers 60+)
Orbilli	256	25	(1 in 10)	3
Berwong	563	25	(1 in 23)	4
Gozire	1350	25	(1 in 54)	5
Kanpuah	120	20	(1 in 6)	2
Zidung	122	20	(1 in 6)	3
Betanglu	265	20	(1 in 13)	3
Total		<b>135</b>		<b>20</b>

### Data Collection and Instruments

The study used a mixed methods approach involving both qualitative and quantitative field data collection. The use of both methods as complements sought to ensure the clarification of results from one method with the results from another (Greene *et al.*, 1989). This enhances the reliability and credibility of the data collected (Creswell, 2009). The study methods used were the combination of focused group discussions, one-on-one interviews and questionnaire survey which covered perceptions about climate change, adaptation strategies and the roles of institutions in the implementation of the adaptation strategies.

The first stage of the research comprised the review of literature on climate change adaptation and implementation with ScienceDirect search engine, Google scholar, website of organizations (UNFCCC). Electronic-mails and telephone calls were made to enquire for reports from individuals and organizations who initiated the implementation of climate change adaptation in the various communities visited.

The questionnaire surveys were designed to collect data on the socio-economic and demographic characteristics of respondents, perceptions about climate change and variability,

adaptation strategies, institutions and their roles in adaptation to climate change. Initially, the household semi-structured questionnaire was developed and pre-tested using randomly selected farmers households in Lawra. Adjustment was made on the flow of the questions and expressions that might confuse the respondents. The questionnaire survey was conducted with 20 households in Kanpuoh, Zidung and Betanglu and 25 householders in Berwong, Orbilli and Gozire of farming families. A total of 135 questionnaires were administered by two enumerators with supervision. The enumerators were trained on how to translate the questionnaire into the local dialect.

A total of six focus group discussions (FGDs) were conducted with smallholder farmers with one in each community. Each FGD was composed of a combination of 6-7 males and 6-7 females. The FGDs were carried out in four communities that developed initiatives towards agricultural adaptation strategies to reduce the impacts of climate change on their farmlands (that is, Orbilli, Gozire, Kanpuoh and Zidung). The FGDs were also carried out in two communities where there was no planned initiative for climate change adaptation by farmers (that is, Berwong and Betanglu). The Focus Groups of 12-14 individuals (both males and females) were formed and discussions facilitated by two local moderators to ensure an open and comfortable interaction. The FGDs were conducted to elicit information on the communities' perceptions about formal and informal institutions as well as their roles in adaptation to climate change and livelihoods. This supplemented and verified the information collected through household questionnaires and key informant interviews. In order to solicit the exact data on the problems of farmers in the community, climate issues were not mentioned in the earlier questions of both the focus group discussions and the interviews. The FGDs averagely lasted for 60 minutes. The discussions were recorded with an audio tape with the permission of the participants which was later transcribed and analyzed without identifying the names of the participants.



In-depth interviews were conducted with 7 key informants in both formal and informal institutions (chiefs, community leaders, government official) to obtain further insights in assessing the awareness of climate change and the adaptation mechanisms of communities across space and time. The one-on-one interview was conducted with 20 participants who were above 60 years of age and were willing to spend some time for in-depth information. The selection of the particular age group for the in-depth interview was to acquire further information about the changing climate over a longer period. Both the focus group discussions and individual interviews were conducted with farmers, community leaders, NGO field agents in Lawra and Nandom Districts.

### **Data Analysis**

The quantitative data from the household questionnaires were coded and entered in the SPSS software version 20. This gave a variety of descriptive and frequency tables, chi-square tests, correlation analysis and graphs which provided the right illustrations for the results.

Recorded interviews and focus group discussions conducted were first transcribed; some of them verbatim or intelligent transcripts. The transcribed interviews were analysed using NVivo version 10. Major themes and nodes were developed from the software based on the interviews and focus groups conducted. This provided further explanation and understanding of the climate change adaptation issues among farmers in the communities.

Climate data on temperature and rainfall variables from 1984-2014 (30 years) was collected from the Ghana Meteorological Department. The Black Volta River (BVR) flow data was also collected from the Water Research Institute (CSIR-WRI). The data was run in Excel for graphical illustration on the variability in climate change over the years and flow analysis for the BVR.

### **Limitations to the study and measures to mitigate them**

One of the challenges faced during this research was with searching and retrieving relevant literature which was necessary for an in depth understanding of the work during the first phase of the research. The researcher used a systematic review strategy in conducting the synthesis. Another challenge faced during the research was in locating the communities and mobilizing the people to open up in the discussion. A contact person was first identified in each of the community visited. The contact persons gave prior notice to the communities about the research and also made necessary arrangements for the meetings. Obtaining previous works from the Ministry of Food and Agriculture (MoFA) and Centre for Scientific and Industrial Research (CSIR) on soil, water and pest and diseases in the region was challenging.

## CHAPTER FOUR

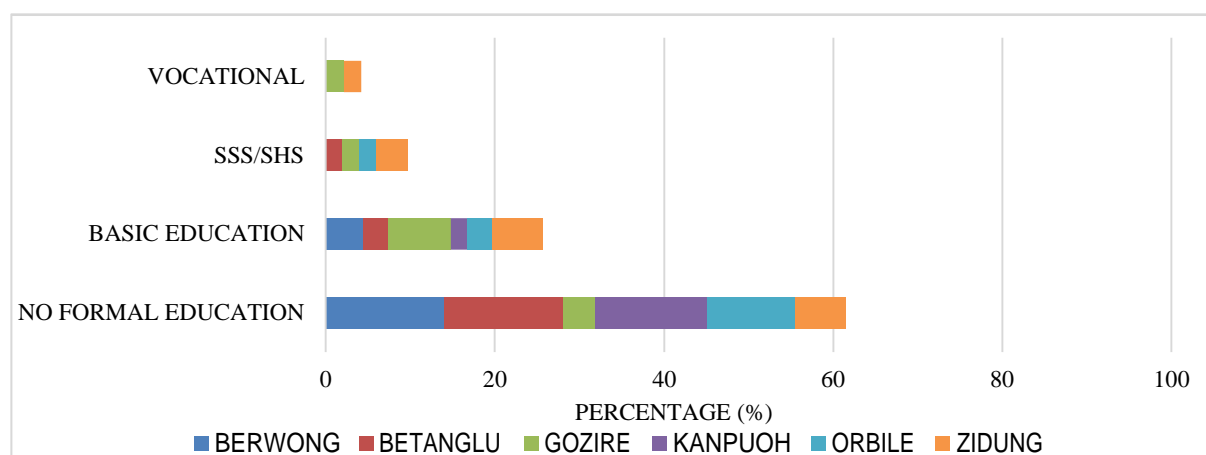
### RESULTS

#### Socio-demographic characteristics of smallholder farmers

It was observed from the study that more than 90% of the respondents in Berwong, Betanglu and Gozire fall within the age ranges of 40-49, 50-59 and above 60. Kanpuoh had more than 60% of its respondents within the range of 50-59 and above 60years range. Zidung has a fair distribution of its respondent across the age range as shown in Table 4.

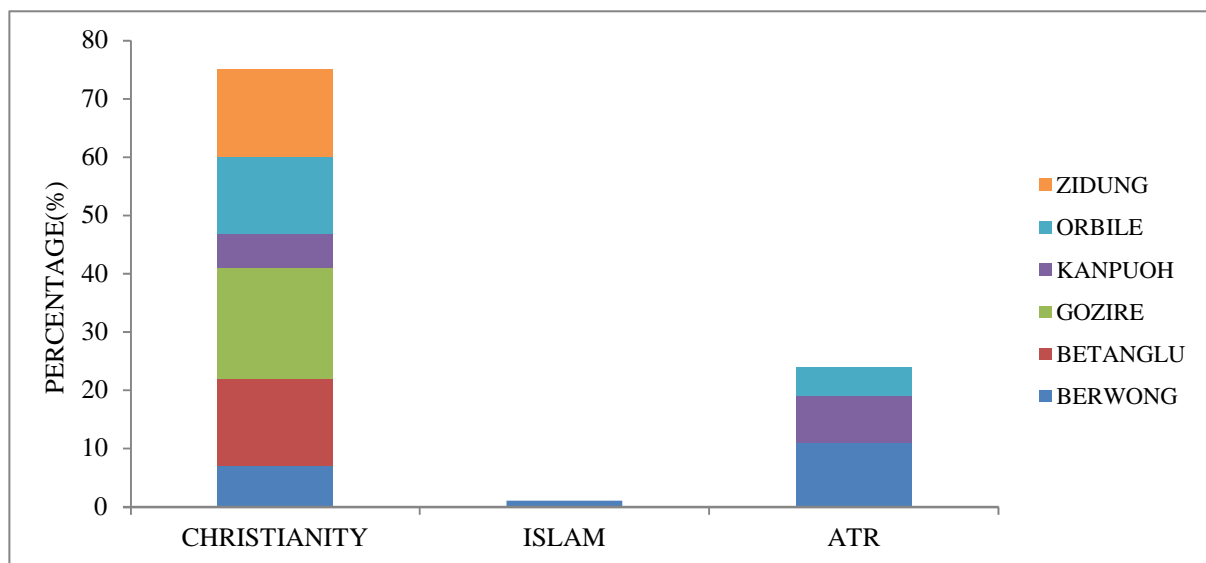
**Table 4: Age group of respondents in the Lawra and Nandom Districts**

COMMUNITIES	20-29	30-39	40-49	50-59	60 AND ABOVE
BERWONG	0	4	28	36	32
BETANGLU	4	4	12	52	28
GOZIRE	0	0	75	20	5
KANPUOH	0	25	10	45	20
ORBILLI	5	30	25	30	10
ZIDUNG	12	24	12	20	32



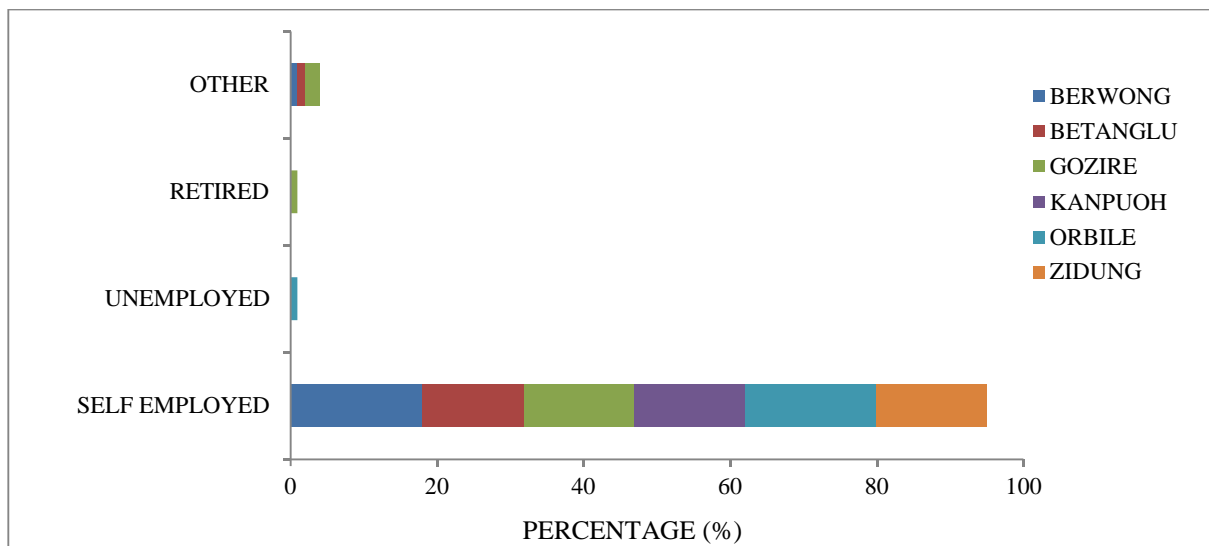
**Figure 3: Educational status of respondents in the Lawra and Nandom Districts**

Most of the respondents (60%) have no formal education with 14% in Berwong, 10% in Betanglu and 13% in Kanpuoh and Orbilli. Less than 30% of the respondents in these communities have a basic education. However, Gozire has more of its respondents (13%) having basic education, Senior Secondary/High School (SSS/SHS) and vocational education. Similarly, Zidung has 9% percent of its population with basic and SSS/SHS education as shown in Figure 3.



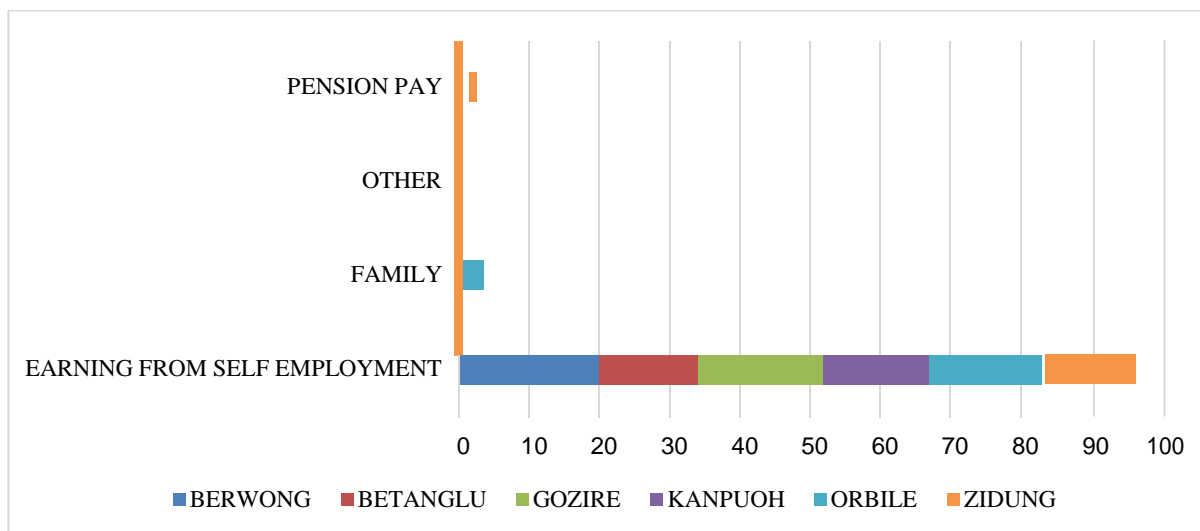
**Figure 4: Religious affiliation of respondents in the Lawra and Nandom Districts**

The Christian religion and the African Traditional Religion (ATR) are the major religions among the respondents, 75% and 24% respectively in the communities. However Betanglu, Gozire and Zidung have all their respondents as Christians. Berwong and Kanpuoh have the majority (11% and 8% respectively) of their respondents following the African Traditional Religion (Figure 4). One percent of the respondents in Berwong are of the Islamic religion.



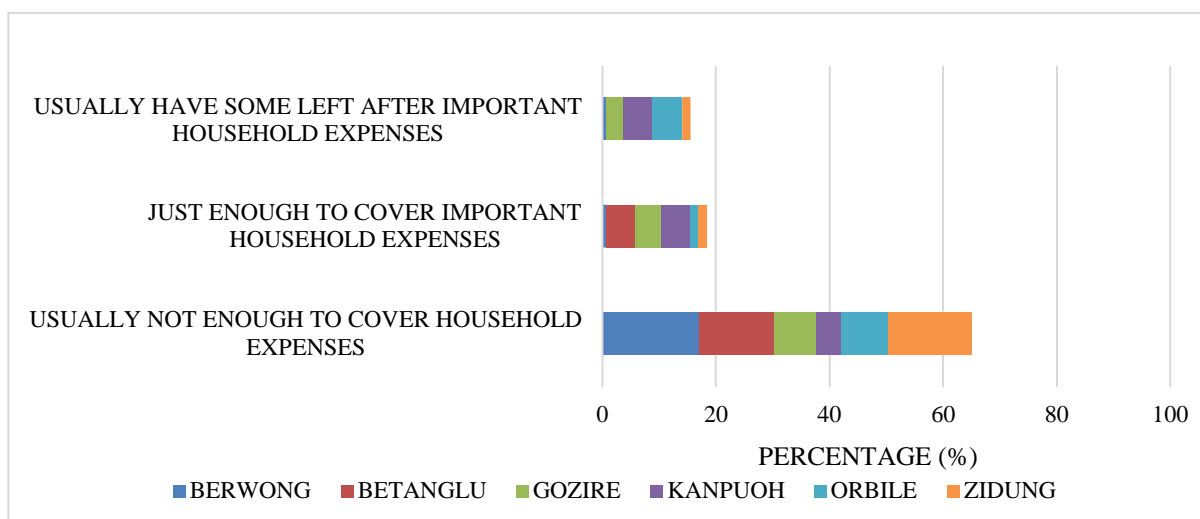
**Figure 5: Occupational status of respondents in the Lawra and Nandom Districts**

The majority of respondents (96%) in all communities are self-employed as shown in Figure 5. Respondents during FGDs confessed that they engage in farming, petty trading and pito brewing. One percent of the respondents from the Gozire community were with the retired cohort who are ex-civil servants. Unemployed respondents are seen only in the Orbilli community. The other occupational categories are construction workers. Respondents indicated that the energetic persons amongst them go to the neighbouring villages to work during dry seasons. In Berwong, male and female farmers go to the neighbouring country, Burkina Faso to collect firewoods for sale as an alternative source of income- FGD. Income from these avenues (other than self-employment) is not sustained, according to one respondent.



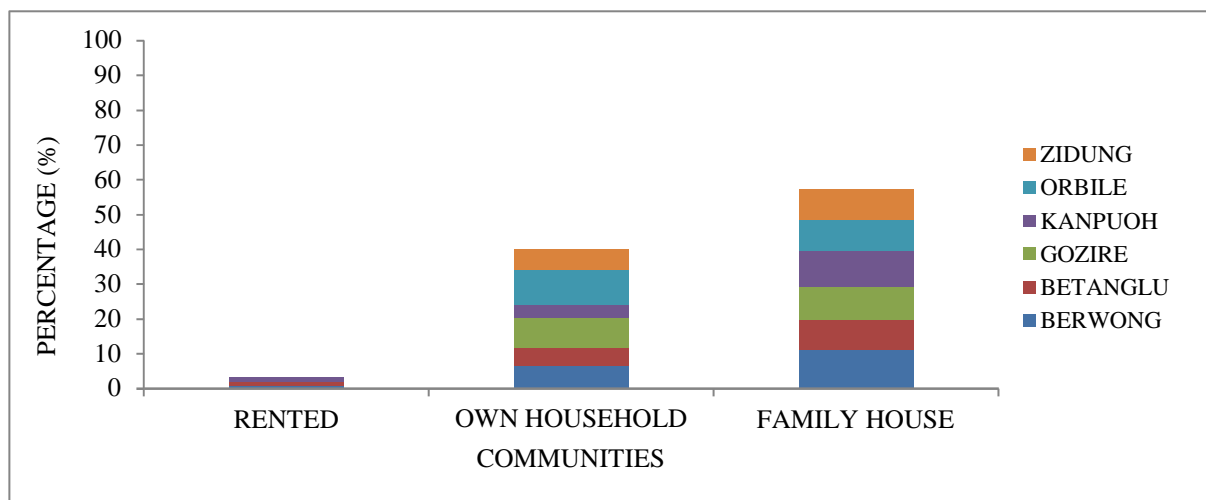
**Figure 6: Sources of household income by respondents in the Lawra and Nandom districts**

Household income (96%) is generated from the sale of farm produce, petty trading and pito brewing (self-employed) in Berwong, Betanglu and Kanpuoh communities. Three percent of the respondents (above the age of 60years) are dependent on family income in Orbilli. This is through remittances from family members from down-south and abroad as stated by a respondent during one-on-one interview in Orbilli (Figure 6).



**Figure 7: Rating of household income from respondents in the Lawra and Nandom Districts**

The majority (64%) of respondents (Figure 7) attest that income generated from farming is usually not enough to cover household expenses. Kanpuoh has 10% of its respondents confirming that income generated from farming is enough and have some left after important household expenses as shown in Figure 7. *‘We get more money through construction works than we do from farming these days, but construction work is temporal’* as stated by a farmer in Zidung.



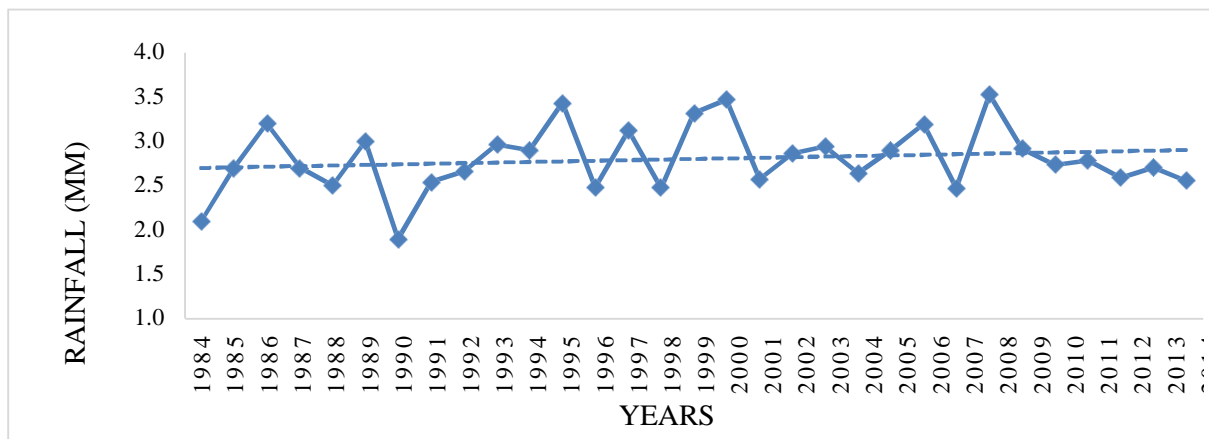
**Figure 8: Household type of respondents in the Lawra and Nandom districts**

Farmers (58%) in all the communities live in family house types of residence (Figure 8). However, three percent of the respondents in Berwong, Betanglu and Kanpuoh live in rented house residence. The remaining percentage (39%) of residents live in own households. The number of residents in a household, ranging from 6-10 (47%) forms the majority in a household particularly in Berwong and Betanglu. Distribution of household residents within the 1-5, and 11-15 range are 35% and 16% respectively in the communities. It is only Zidung community that recorded two percent of household numbers within 16-20 range.

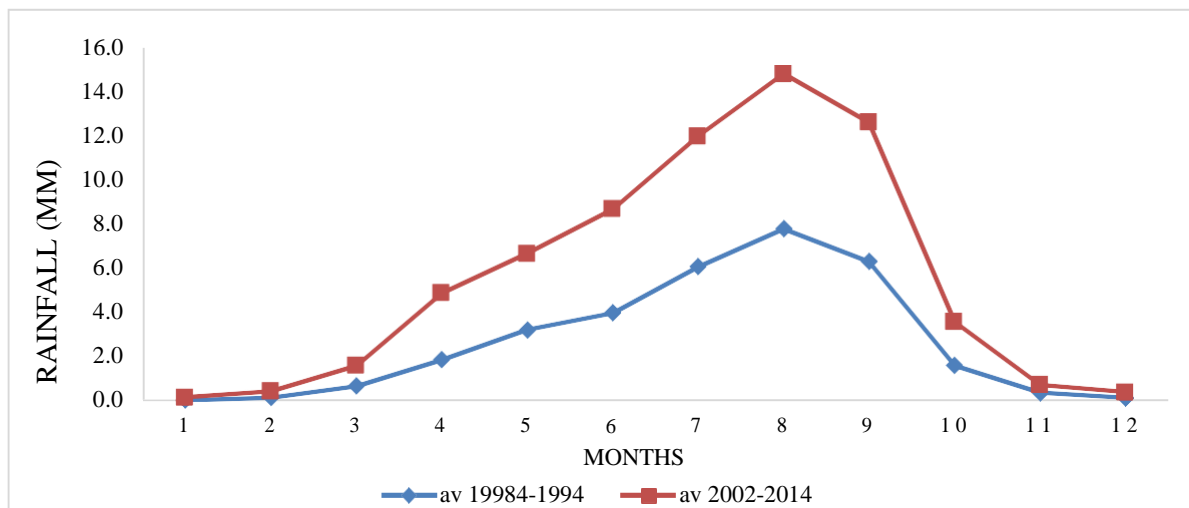
### **Perceptions of smallholder farmers about climate variability/change**

The research findings show that, 100% of the farmers interviewed in Betanglu, Gozire and Orbilli are aware of the term climate change/variability. Berwong, Zidung and Kanpuoh communities have 84%, 88% and 95% of respondents respectively who have heard about the

term climate change. The remaining percentage of respondents who have not heard about the term, have observed changes such as increasing temperatures and irregular rainfall in the weather/climate over the years. High temperatures together with low and irregular rainfall pattern are experienced by farmers in all the six communities. The climatic data from Babile station on the annual rainfall over (30 years): 1984-2014 show a slightly increasing trend in rainfall with inter-annual variability (Figure 9).



**Figure 9: Annual rainfall pattern in Upper West Region over 30 years (1984-2014)**

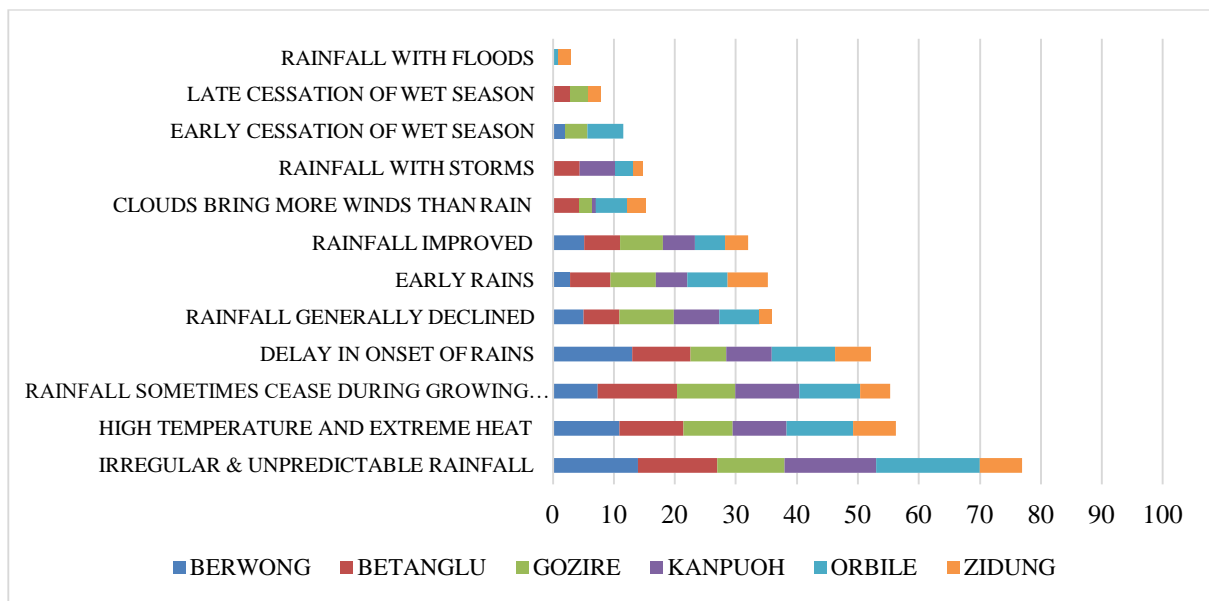


**Figure 10: Change in rainfall in Upper West Region over the years (1984-2014)**

A change detection analysis between the first 10 years (1984-1994) and the last 10 years (2002-2014) of rainfall data shows an elevated amount of rainfall over the years from June to

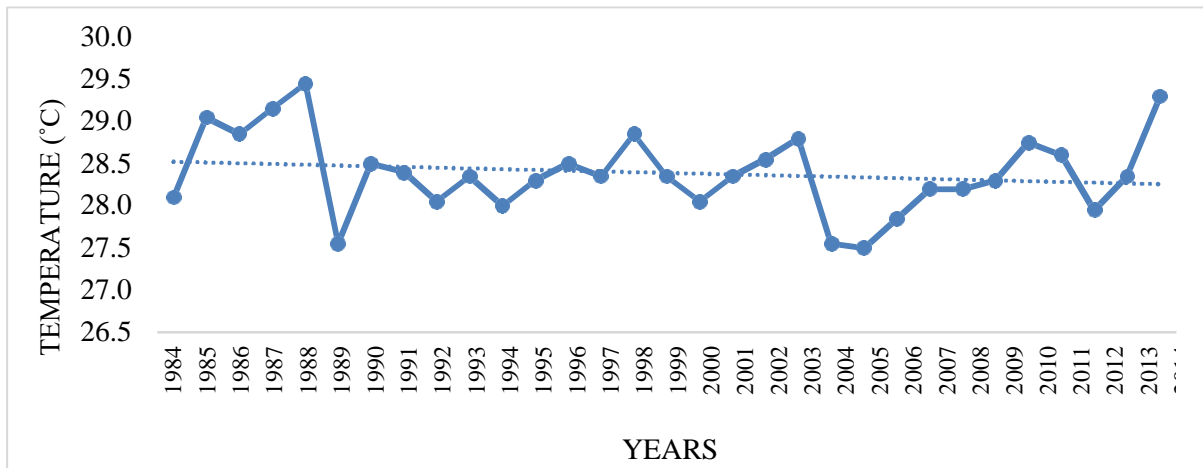


August (Figure 10). A large number of the respondents observed irregular and unpredictable rainfall (77%), that high temperature and extreme heat (56%) and rainfall sometimes ceases during growing season (55%) as the main changes in the past years (Figure 11). In an interview with the chief of Betanglu, Naa Batholomew Depuur, he observed that *“the increase in temperature has resulted in drying up of the soils which makes it more difficult to farm as it requires more water to moisten the soils. The extreme heat observed recently in the weather has resulted in high death of livestock in the community”*. Nonetheless, 32% respondents also observed early rains and improvement in the rainfall.

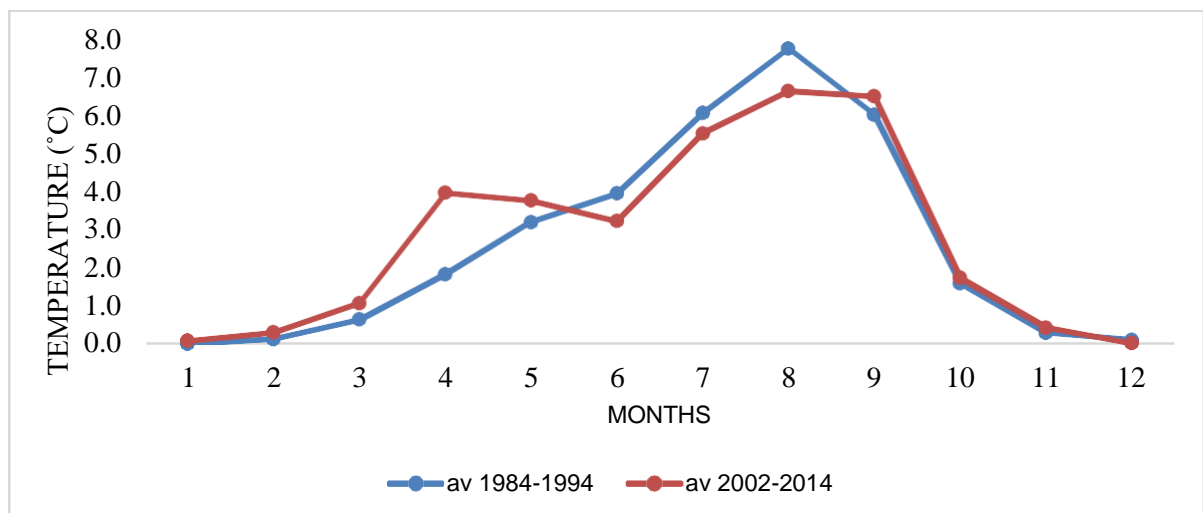


**Figure 11: Observed changes (percentage of respondents) in weather patterns in Lawra and Nandom Districts**

Average temperature in the Upper West Region shows a slight decrease from 1984 to 2014 (Figure 12). A change detection analysis was done using the first 10 years of the climate data (1984-1994) and the last 10 years of the data (2002-2014). The result (Figure 13) shows a steady rise in temperature from April to August and then a rapid decline from the month of October through to December.



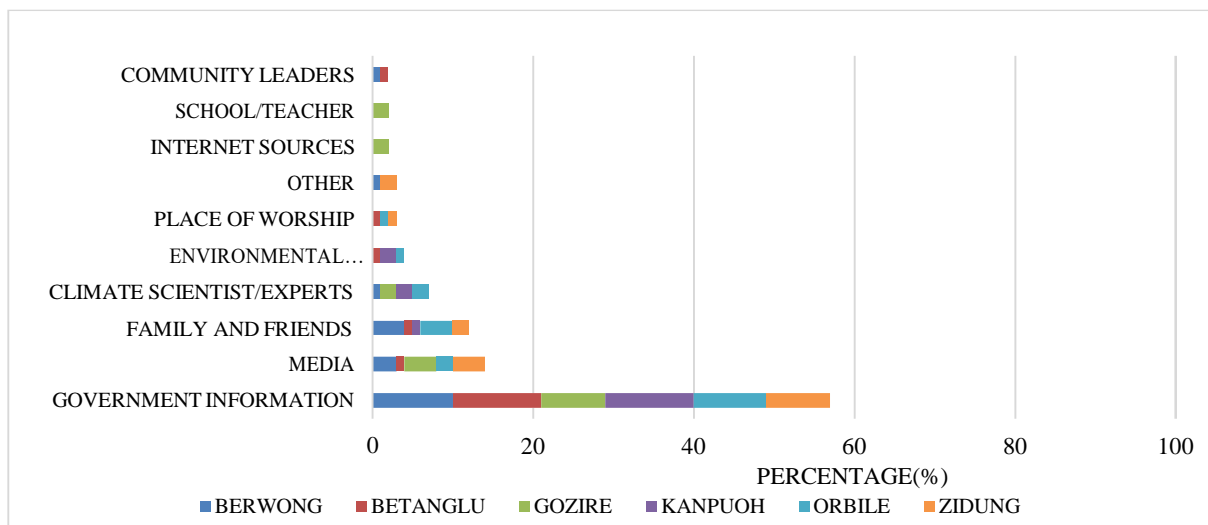
**Figure 12: Annual temperature in Upper West Region within the last 30 years (1984-2014) from meteorological data at CSIR**



**Figure 13: Monthly temperature in Upper West Region within the last 30 years (1984-2014)**

For those who have heard about climate change, a government agency is the main source of information in all the six communities (52.6%), followed by the media (14.1%) and family/friends (12.6%) (Figure 14). Information from school/teacher and internet sources were obtained and utilized by respondents only in Gozire (8%). The government agency identified as information providers in the survey is the Ministry of Food and Agriculture (MoFA) as stated in all six FGDs. In an interview with a contact person in Gozire, he stated that, information dissemination by MoFA is carried out by the extension officers in the district

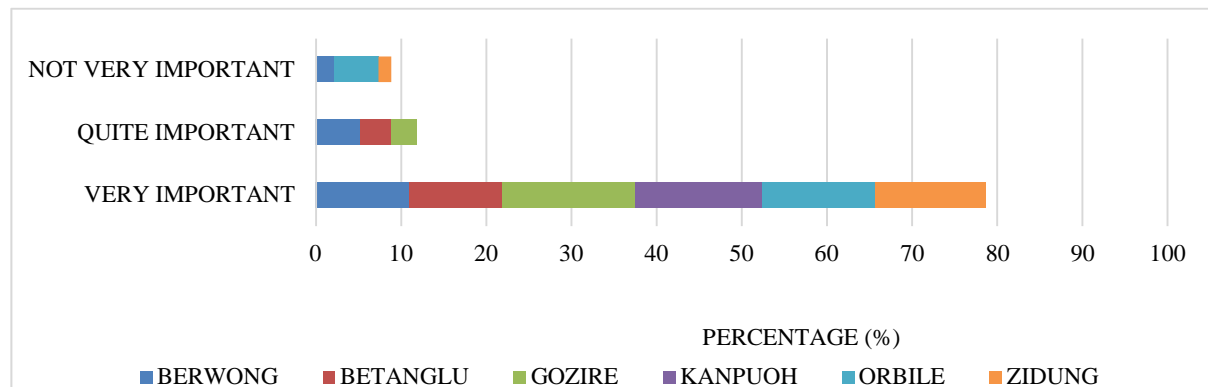
through community contact persons. Farming along ridges, use of early maturing crop varieties, the use of composts are some climate change/variability information provided by the government agencies. The Freed and ‘WOW’ radio stations and Ghana Television are the media agencies disseminating climate change information in the Districts. Most of the information from these outfits is on early warnings about the onset of rains, changes in the weather, warning against deforestation and bush burning in an interview with a radio presenter.



**Figure 14: Sources of climate change information in percentage**

The level at which farmers trust the information received from the various sources has influence on the extent and their willingness to use that information. *‘We have really benefited from the use of compost on our farms as taught by Agric’-FGD in Zidung.* In the same community, most of the farmers do not use information on early warnings of rains that come from the extension officers because of inaccuracy. *‘We end up losing more yields when we follow the announcements from the extension officer’-* in-depth interview with an elderly woman. Overall, the majority of the farmers (60%) trust information obtained from the government as compared to other sources. However, farmers attach much interest to climate change issues due to their belief in the direct impact of climate change on farming activities. The majority of the respondents (80%) in all the communities believe that issues related to climate change are very relevant to their lives (Figure 15). Communities such as Berwong,

Orbilli and Zidung had respondents who do not think issues about climate change are important to their lives.



**Figure 15: Relevance of climate change issues to smallholder farmers**

The educational level of the respondents did not influence their understanding of climate change. Responses from the FGDs as well as the individual interviews among farmers on their knowledge about the term climate change indicated that, some farmers did not understand the definition of climate change. In Kanpuoh, a female farmer testified that, *‘they were taught how to farm along ridges and not to cut trees’* when asked to explain her opinion on climate change. Some of the farmers attribute the observed changes in the weather/climate to traditional beliefs and superstitions.

A farmer in Orbilli lamented that, *‘we are now suffering from low rainfalls, high temperatures and poor soils because our ancestors are annoyed with us.’* He further added *‘we don’t offer sacrifices when accidents occurs, thus rains are seized by the gods to punish us.’*

**Climate change impacts on agriculture (impacts on crops and livestock)**

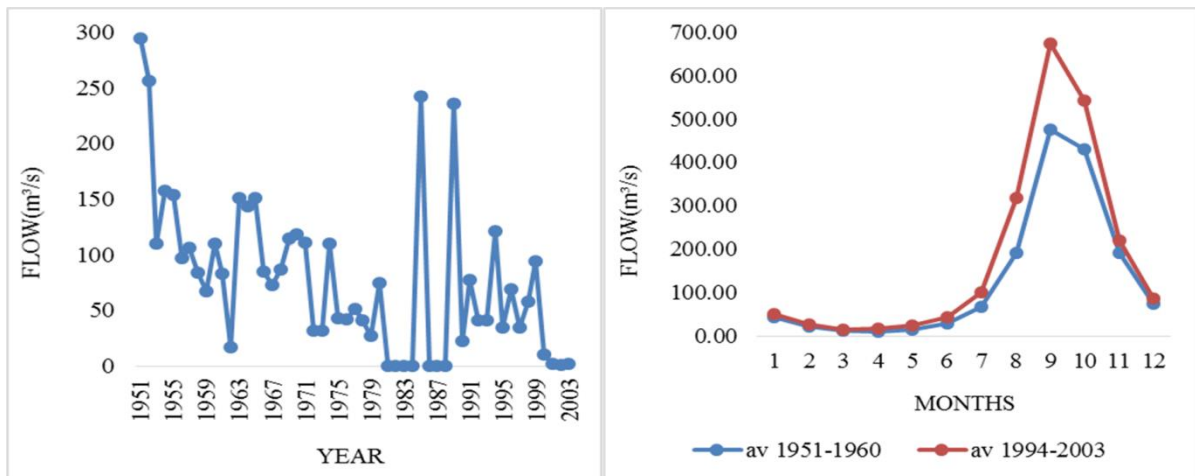
**Water**

The observed decrease in the water level of Black Volta recently has resulted in a water struggle between the Orbilli farmers and the Fulani herdsmen- FGD at Orbilli as shown in Figure 16.



**Figure 16: Dry season gardening near the Black Volta River**

Farmers in communities closer to the Black Volta (for example Orbili) engage in dry season gardening according to the contact person. Farmers cultivate vegetables such as pepper, tomatoes, garden eggs, okra among others, using the river as a source of water-FGD. Income generated from the sale of the farm produce, supports the up keep of households. Decrease in the river flow makes this type of farming difficult and expensive as discussed during FGD. The use of pump and hose is now required by weak and older farmers for irrigation purposes from the river as stated from the FGDs in Orbili. The monthly flow data of the Black Volta over the past 52 years (1951-2003) has shown a decrease (Figure 17a).



**17a**

**17b**

**Figure 17: (a) Annual and (b) monthly flow analysis of the Black Volta River (1951-2003) Annual and monthly**

Change detection was created using the first 10 years and the last 10 years of the data. An increase in flow was observed from July to October with a peak in September (Figure 17b).

**Table 5: Present and past crops grown in the communities**

District	Community	Crops grown presently	Crops grown 10 years ago
Nandom	Goziire	Dorado, Maize, Rice, Chinese and local groundnuts, Yam, Beans and cowpea	Guinea corn, Millet, Local groundnut and Maize
	Betanglu	Groundnuts, Dorado, Maize, Rice and Sorghum	Maize*, Rice and Sorghum
	Zidung	Maize, Groundnuts, Dorado, Rice and Yam	Maize, Groundnuts, Rice and Yam
Lawra	Berwong	Improved maize seeds, Sorghum, Groundnuts and Beans	Maize, Sorghum, Groundnuts and Beans
	Kanpuoh	Sorghum, Groundnut, Millet, Rice, Beans and Maize	Sorghum, Groundnut, Millet, Rice, Beans and Maize
	Orbilli	Groundnuts, Maize, Sorghum, Yam, Cowpea and Vegetables	Groundnuts, Maize, Sorghum, Yam, Cowpea and Vegetables

\*Not in commercial quantities

Source: Field Data, 2017

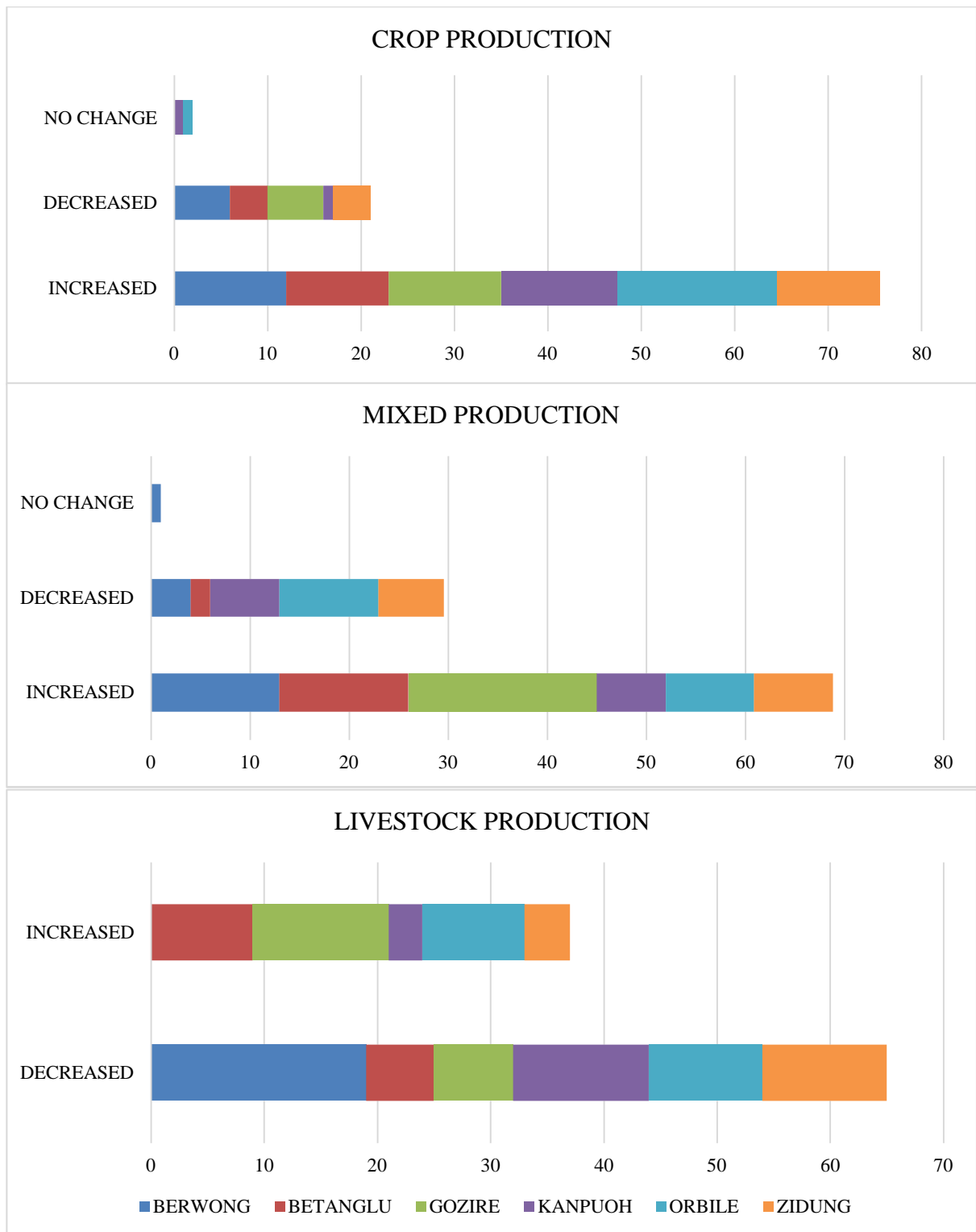
Table 5 shows that, currently, more crops are cultivated by the farmers in Nandom district than the last 10 years. Dorado is a new variety of sorghum presently produced in all the communities within the Nandom district. The crop variety is usually harvested as it matures within 3 months of propagation and has good price in the market as discussed at a FGD in Betanglu. They added that they cultivate more of Dorado and maize for sale and household consumption, respectively.

#### Pests and Diseases

Pre-harvest and post-harvest losses of crops are key and mainly due to the prevalence of pest and diseases. *“We used to have pests and diseases infestations over the last 10 years but that*

*was seasonal so we plan against it. The time of the infestation now is unknown. It comes at any time, as I am speaking to you, my mango plantation has been infected”-farmer at Orbilli.*

Crop and mixed production were observed to increase over the past 10 years by 76% and 69% of respondents respectively in all communities. No change in crop production was observed by respondents from Kanpuoh and Orbilli communities. A 30% decrease in mixed production is realized in all communities except Gozire. Pigs, sheep, cattle and fowls are the major animals reared in the two districts as emerged from the FGDs. In addition, a retired civil servant at Zidung during an in-depth interview said, *“I have lost all my pigs and fowls over the past few years due to sudden deaths which I cannot tell but I believe it’s the increase in temperature over the years.”* He added that, *‘the pigs now die faster than their reproduction’*. He explained that his loss in livestock production has kept him away from rearing farm animals. For livestock production, communities that observed increase were Betanglu, Kanpuoh, Orbilli, Gozire and Zidung by 37% of respondents as shown in Figure 18. A farmer from Kanpuoh in a focused group discussion disclosed about rampant increase and subsequent spread of pest and diseases which has decreased total output in crop production which is contrary to majority of respondents in the community.



**Figure 18: Changes in agriculture production (percentage respondents) in the last 10 years in Lawra and Nandom Districts**

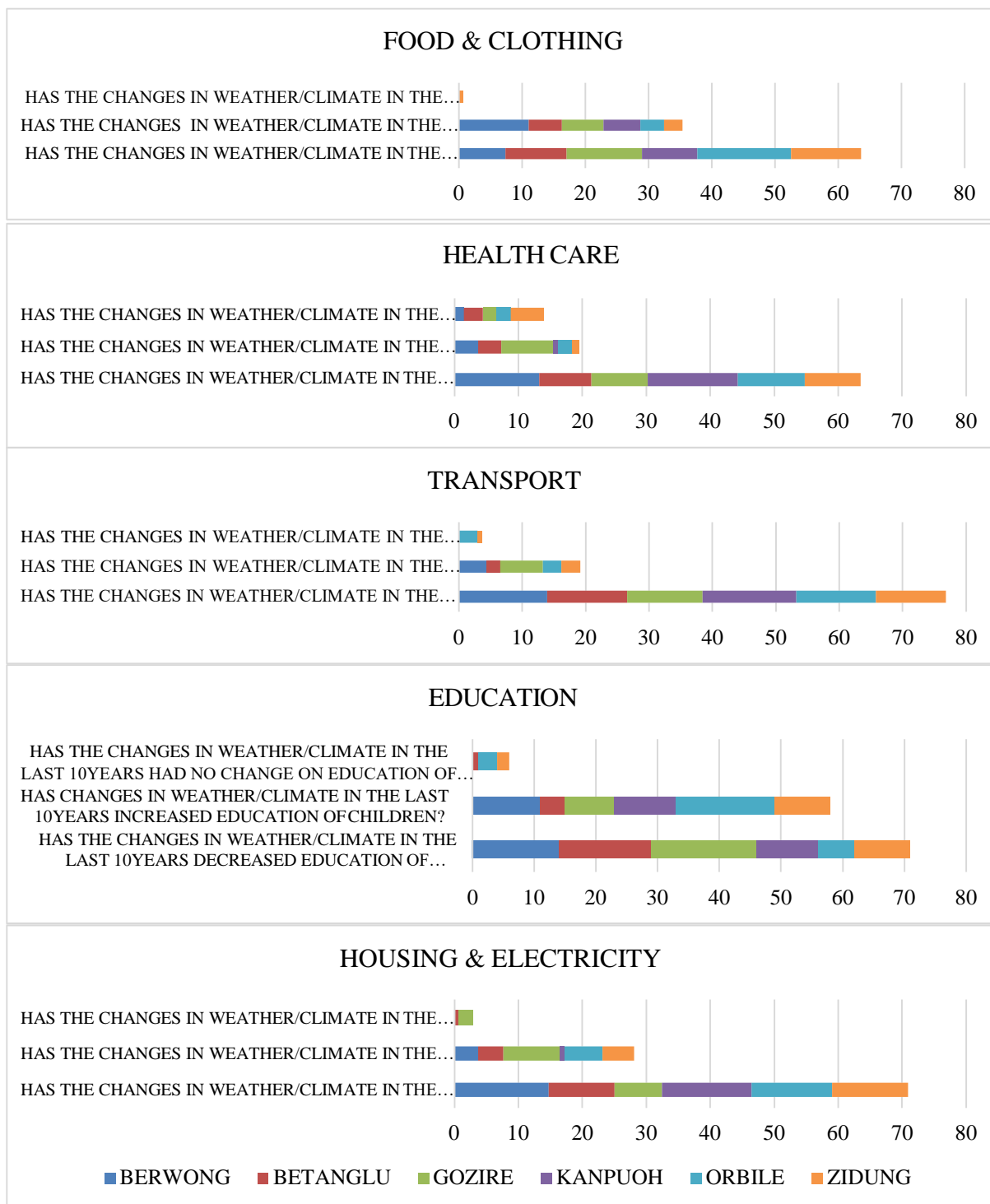
The leader of the women’s group in Zidung stated that, “*every woman in this community received a goat from Agric (MoFA) to serve as support.*” In Berwong, an extension officer



stated, *'most of our farm animals have been stolen by the Fulanis whilst some died naturally due to high temperatures.'*

### **Climate change impacts on agricultural livelihoods**

Based on the following livelihood indicators: food & clothing; health; education; housing, electricity & water; and transport, farmers' perception of their vulnerability to climate change impacts on agricultural livelihoods were determined (Figure 19). Majority of respondents in Zidung, Orbilli, Kanpuoh, Gozire and Betanglu observed an increase in food & clothing with only Berwong indicating a decrease in food & clothing, as a result of changes in weather/climate in the last 10 years. In a FGD in Betanglu, respondents explained that the introduction of new sorghum varieties (*Sorghum bicolor*, locally known as *'dorado'*) provided by the Agriculture extension officers in 2012, has rather provided them with additional food choices. With regards to health, no changes were perceived by the majority (>50%) as a result of changes in weather/climate. Although hospitals cost have generally increased, respondents observed no change because they use herbal medicine which is cheaper than hospital. In communities such as Orbilli and Gozire, however, more than 40% reported decrease in the health sector in the last 10 years. A female farmer in Orbilli blamed increasing health costs, narrating that *'within a period of 4 years, the cost for National Health Insurance Scheme (NHIS) card increased by more than 100% in which drugs are excluded. It used to be GH¢4.00 in 2013 but GH¢20.00 in 2017.* In all the communities, with the exception of Orbilli, majority of respondents believe that there has been a decrease in the education of their children as a result of the changes. They attributed this to the low crop yields in the community which brought in inadequate income to support their children's' education. For all communities, majority indicated that transport and housing facilities showed no changes.



**Figure 19: Observed changes in livelihoods indicators (percentage respondents) in the last 10 years in Lawra and Nandom Districts**

## Climate change adaptation among smallholder farmers

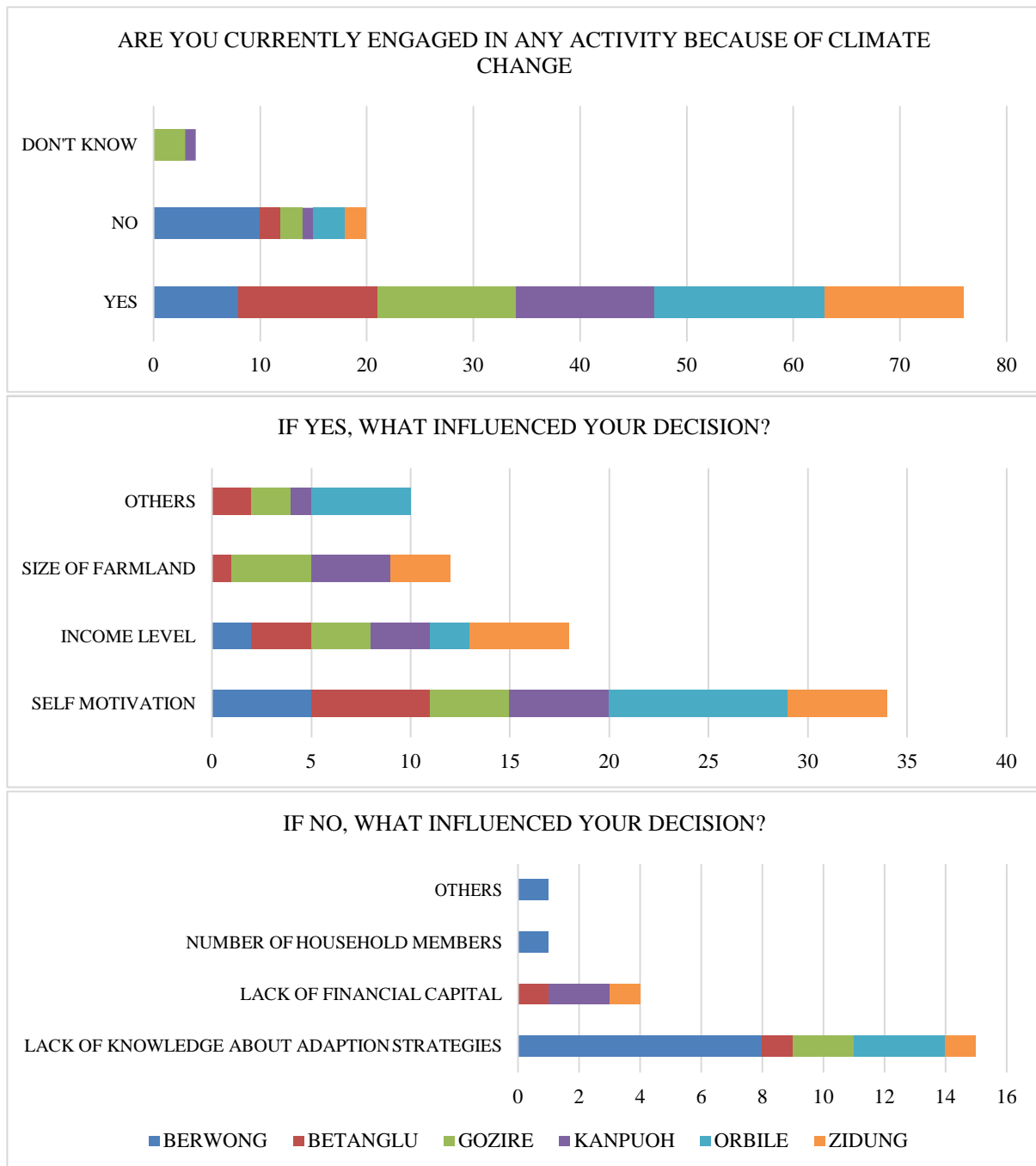
Farmers perceived problems of agricultural production in the last 10 years are ranked in order of significance as follows;

1. Insufficient rains,
2. Low soil fertility and
3. High cost of farm inputs (including ploughing)

These were ranked as the top three problems in all communities. Pests and diseases was ranked in the top five categories of agricultural problems in all communities in the last 10 years except Gozire and Betanglu where it was not mentioned at all. *Despite the toil on the lands and high cost of fertilizer and tractors the price of one 'olonka' (one kg) of groundnut is just GH¢8.00*, this statement was made by the head of market women in Orbilli.

All six communities are engaged in agricultural adaptation strategies to mitigate climate change was confirmed by 77% respondents. However, only 10% of respondents in Berwong were engaged in agricultural adaptation activity to mitigate climate change. Respondents who affirmed their engagements in some activities because of climate change are either self-motivated (34%), or have sufficient household income (17%) to support activities such as the purchase of new crop varieties and farm size (12%) (Figure 20). Small farmland sizes supported composting whilst bigger farmland size supported shifting cultivation and mixed farming for farmers as discussed during a FGD at Gozire. The other factor that contributed to the farmers' engagement in other activities is the availability and access to information about climate change agricultural adaptation strategies to farmers. The remaining respondents who do not engage in any climate change agricultural activities believe that the lack of knowledge about climate change agricultural adaptation strategies, inadequate capital and no access to credit facilities are barriers to climate change adaptation. Agricultural adaptation in this

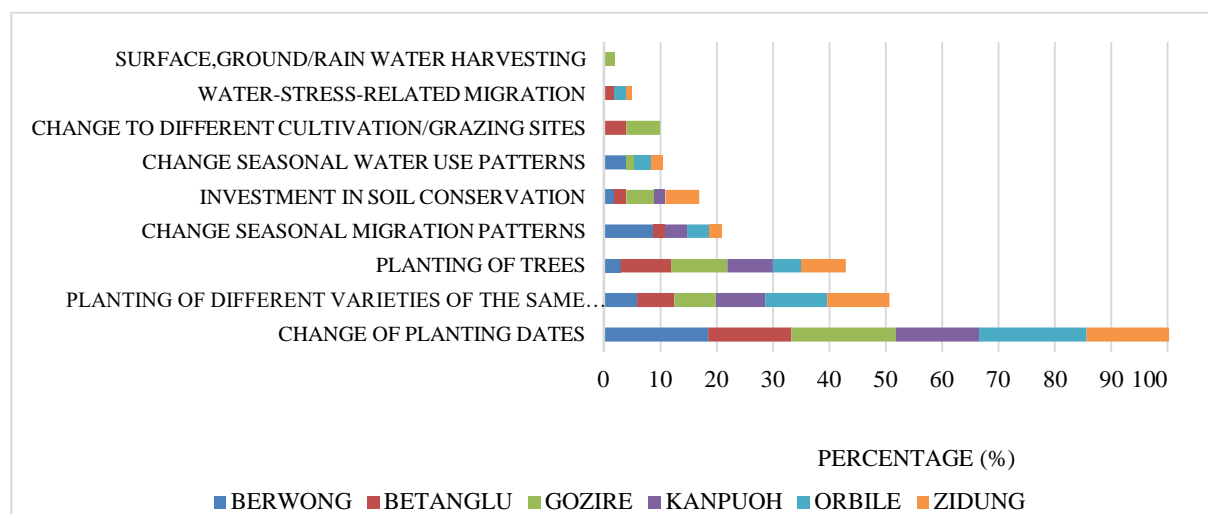
context is any activity/strategy that smallholder farmers engage in order to reduce the negative impacts of climate change and maximise output.



**Figure 20: The basis of communities decision to undertake climate resilient agricultural adaptation**

A correlation analysis was done using education and the likelihood of farmers to adapt to climate change adaptation. A negative correlation (-0.130) was derived which means that higher educational level did not influence the ability of farmers to adapt to climate change.

The major agricultural climate change adaptation strategy respondents engage in all communities is the changing of planting dates (100%). Planting of different crop varieties (50%), planting of trees (43%) and change in seasonal migration patterns (21%) as the next most practiced activities in all communities with the exception of Berwong which has seasonal migration pattern as the next dominating practice after changing of planting dates in the community as shown in Figure 21. In Gozire at a FGD, one of the male farmers stated that, each farmer creates a small pond on the farm to collect water during raining seasons to be used in the lean season. He added that, the collected water supports farming for a while as it dries up easily.



**Figure 21: Agricultural adaptation strategies in Lawra and Nandom Districts (\*multiple answers per respondent)**

In both districts, individual adaptation options are linked to community based adaptation strategies. For example, in Gozire, the community minimized deforestation and bush fires as a way to control and maintain the soil quality under the changing climate. This manifested in higher crop yield and the general livelihood of the people according to the contact person.

## **Climate change adaptation and institutions**

### 4.6.1 Institutions

Formal institutions found in both districts include government agencies, Non-Governmental Organizations (NGOs) and research institutions. Chiefs and farmers/producers association were the informal institutions identified in the districts. Institutions play different but related roles in the implementation of climate change adaptation.

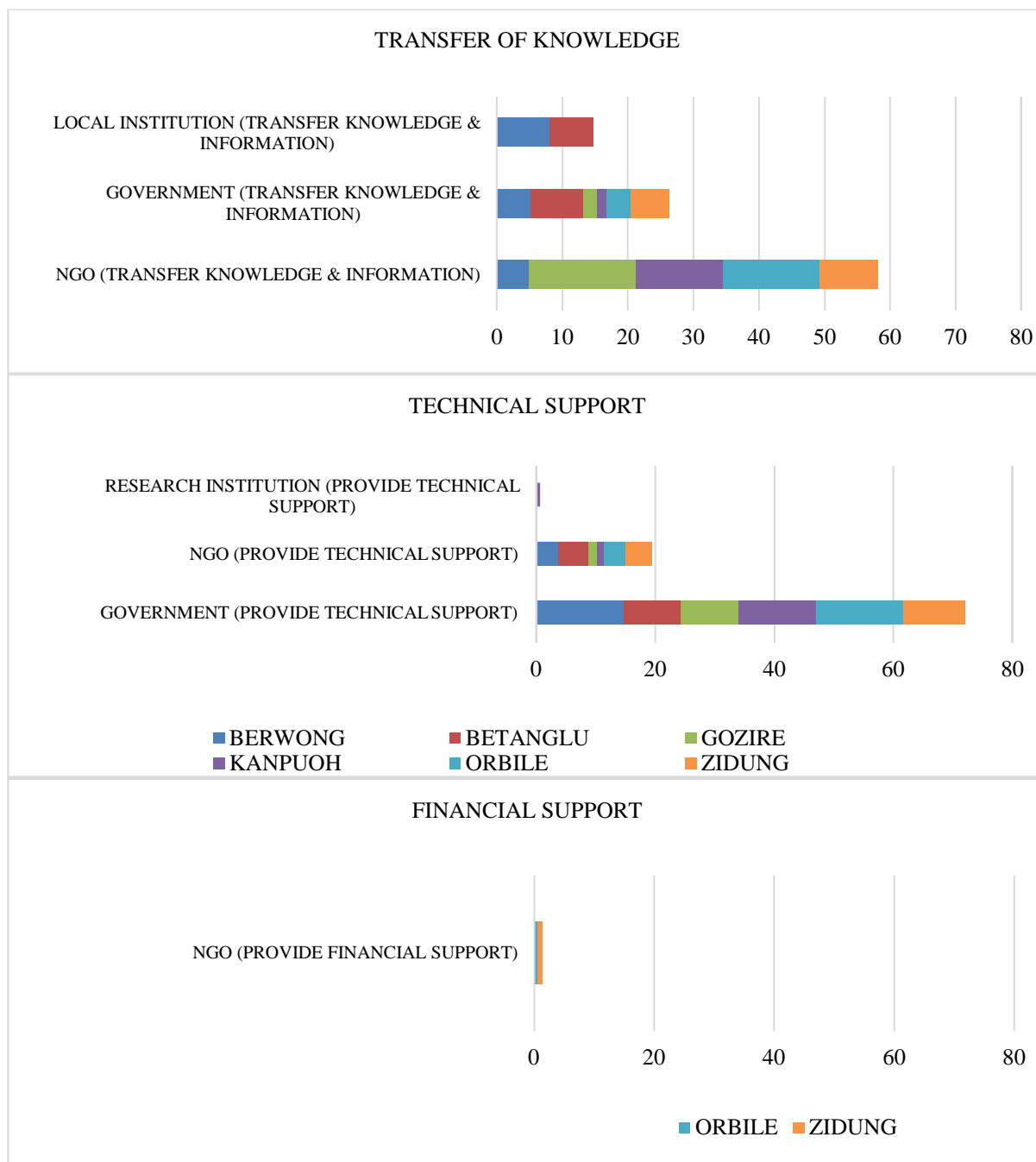
#### Formal institutions and their roles in climate change adaptation

##### *Government*

Government agencies such as the Ministry of Food and Agriculture (MoFA), Savannah Agricultural Research Institute (SARI), the Ministry of Environment, Science, Technology and Innovation (MESTI) and the Environmental Protection Agency (EPA) have representatives at the District Assemblies who work closely with the local farmers. These institutions play different but related roles in the implementation of climate change adaptation strategies. The extension officers provide weather information to farmers in the communities either through contact persons in the community, through the radio stations or through the chiefs. The respondents indicate that the extension officers inform them about the rainy seasons and planting dates at least a month earlier to the beginning of cultivation.

With respect to technical support to farmers, the extension officers have taught most of the respondents composting in order to boost the soil quality in the area, especially in Zidung and Kanpuoh. In an interview with an elderly woman in Zidung, she explained that *'We were taught making use of our domestic waste by converting it into compost and use on our farmlands by Agric'*. This technique has retained the soil fertility and increased our farm production in recent years'. According to the respondents, government agencies do not provide any form of financial support to their communities but provided avenues for farmers

to acquire loans through the introduction of the Village Savings and Loan Association (VSLA).



**Figure 22: Perceived roles of formal institutions in climate change agricultural adaptation**

### *Non-Governmental Organizations (NGOs)*

The NGOs identified in the communities are either locally based or foreign based who provide significant support in the field of agricultural climate change adaptation. The Centre for Indigenous Knowledge and Organisational Development (CIKOD), CARE International, ESOKO, Nandom Deanery Integrated Rural Development Program (NANDIRDEP) were some of the active NGOs associated with climate change adaptation in the districts at the time of the survey. These NGOs also provide information/knowledge transfer to farmers in the communities. Three of the NGOs programme coordinators (CIKOD, ESOKO and NANDIRDEP) were contacted for interviews. For example, NGO such as CIKOD concentrates on food security under climate change by providing improved crop variety (groundnuts) to the local farmers in Gozire. In Orbilli, ESOKO supports agricultural adaptation by providing agricultural information through text messages to farmers. According to an extension officer in Gozire, *'external institutions consider the activities community members are engaged in before they provide their support.'* For instance, *one of the main challenges this community encounters is the threat of bushfires from neighbouring communities. CIKOD observed the commitment the community has made towards zero tolerance to bush burning and deforestation and then organized fire service training for the youth in the community. The NGO also provides some materials to the community for safety fire fighting.'* Care International also supports farmers by providing storage facilities to farmers in Betanglu in FGD. According to an interview with Mr. Banuoko (Deputy Director of CIKOD), he states that the NGO also provides marketing training to the women to support the sale of farm produce.

In terms of financial support received from NGOs, in Orbilli, this was in the form of wages to farmers for working on their farms through projects such as the World Food Programme (WFP) and Farm Plus by Care International; and in Zidung, subsidized fertilizer and VSLA training from MoFA and provision of small dams for farming in dry season and storage



facility by Care International. This project also encouraged farmers to work on their farms using proper soil conservation techniques and creating dams as an alternative water source during dry seasons.

### *Research Institutions*

Research institutions that visit the two districts were University of Development Studies (UDS) Wa and Tamale campus, University of Ghana (UG) and, Kwame Nkrumah University of Science and Technology (KNUST). These are students or senior researchers who go to the communities to collect data for research purposes only. The Council for Scientific and Industrial (CSIR) also conducts research in some of these communities. Research institutions did not provide knowledge/information transfer, technical or financial support to farmers in any of the communities surveyed. According to the chief of Betanglu, *their community most often get student researchers who come to conduct research.*

**Table 6: Major adaptation options, type of support and responsible institution**

<b>Adaptation Options</b>	<b>Institution</b>	<b>Type of support</b>
Adopt varieties of same crop	MoFA, CIKOD	Information & knowledge transfer and Technical support
Change planting dates	MoFA	Information & knowledge transfer (early warning information)
Change to different cultivation/grazing sites	MoFA-	Information & knowledge transfer - new farming methods (farming along ridges and stone bonding)
Crop diversification	MoFA, CIKOD	Information & knowledge transfer and Technical support
Diversify into non-farm income	VSLA	Information & knowledge transfer
Investment in soil conservation	CARE International MoFA	Information & knowledge transfer and Technical support; CARE International (v2 project- nitrogen fixing crops) MoFA (composting)
Tree planting	MoFA CARE International	Information & knowledge transfer and Technical support

MoFA- Ministry of Food and Agriculture; CIKOD- Centre for Indigenous Knowledge and Organisational Development; VSLA- Village Savings and Loan Association

## Informal institutions and their roles in climate change adaptation

Chiefs (paramount and sub-chiefs), community leaders, farmers/producers associations and market women groups were the main informal institutions identified during the survey in the districts.

### *Traditional authorities*

Apart from social responsibilities, chiefs enact and enforce strict measures for the achievement of a communal goal such as strategies geared towards climate change adaptation; in an interview with Naa Christopher of Zidung. In Gozire for example, punishments to culprits for bush burning by the chief served as a deterrent to other potential culprits-contact person narrates. The chief of Zidung indicated that *stricter measures/bye laws are put in place to check both social and environmental controls in the community.*

### *Farmers/producers association*

Farmers/producers association also aid in climate change information dissemination on early warning systems. These associations are active in Gozire and Orbilli. *Those of us who don't have radio tapes get early warning information from the head of farmers' group-* FGD at Gozire. Formal institutions interact with the community through development of projects which has been accepted and approved by the local chiefs; as mentioned by the chief of Betanglu. There is also collaboration among the institutions in the implementation of climate change adaptation options as is shown in Figure 23.



**Figure 23: Signboards showing the collaboration of institutions in climate change adaptation projects**

The majority of the NGOs that visit the communities work in alliance with the existing local institutions. For example, Oxfam collaborates with NANDIRDEP in all the communities within the Nandom districts as shown in Figure 23.

Different adaptation strategies were identified through the responses from questionnaire survey and FGDs. The responses were categorized under community, types of adaptation strategies and roles of the institutions that supported these strategies (Table 7).

#### **4.7 Achievements, challenges and way forward for institutions in climate change adaptation**

The communities identified some successes and challenges with the institutions during the FGDs and interviews as shown in Table 7. Even though majority of the criticisms was on government to tackle climate change through poverty alleviations, interviews with some government officials also suggest inadequate financial support from international donors.

**Table 7: Achievements and challenges of activities institutions to climate change adaptation as perceived by the communities in Lawra District**

<b>Institution</b>	<b>Description</b>	<b>Achievements</b>	<b>Challenges</b>	<b>Way forward</b>
Government Agriculture extension	Provide knowledge and Technical skills to farmers	Taught composting, how to farm on ridges and stone bonding	They made the community people open up their problems, but they did not solve it (poverty)	Fertilizer support Money
NGO (CARE International)	Farm plus project: Selected poor and needy people to work on their farms and converted it into food	Paid farmers for farming on our own lands	The selection was biased and selected persons did not provide information to the community after the training	It should involve all community members
	V2 project: Farmers were taught on nitrogen fixing crops	This helped to improve soil quality	The project was short lived (not more than two years in Orbilli)	Wish it could be sustainable (long lived)
	WFP: Farmers were asked to dig dams for farming (irrigation)	Paid for the hours they constructed the dams and now the animals drink from the dams	The project was short lived (not more than two years in Orbilli)	Wish it could be sustainable (long lived)
Local institution (Chief)	Create awareness Enforces the laws (helping to fine culprits for the benefit of the community)	Deter potential culprits	Bureaucracy in dealing with issues	Should be given more recognition

**Table 8: Achievements and challenges of activities institutions involved in climate change adaptation as perceived by the communities in Nandom District**

<b>Institution</b>	<b>Description</b>	<b>Achievements</b>	<b>Challenges</b>	<b>Way forward</b>
Government Agriculture extension (MOFA)	VSLA: Farmers advised to save and take loans from the savings.	Farmers provided with saving boxes, Sustainable The institution is pleased with the communities performance	No seed money was provided for a start	Farmers want a dug out for storing water during dry season (for animals and dry season gardening)
	Advised on the dangers of bush burning and cutting down of trees	This was supported by traditional rulers and stricter measures were put in place to ensure no tree is cut. Gave farmers some seedlings for tree planting Provided farmers with cutlasses, Wellington boots and spray machines to quench fire during fire outbreak.	Trees could not survive the existing weather. Few trees thrived in Zidung and Gozire.  The tools used to fight bushfires are not enough	Trees that thrive well in specific communities should be provided
	Taught farmers composting, soap making and Shea processing.	This provided an alternative source of income for the farmers	Few processing machine was provided Maintenance of the machine was difficult	This only benefits the women in the community and not all farmers
NGO (CARE International)	Provided storage facility for farm produce (Betanglu, Zidung)	The facility guard or produce against pest.	The facility is not enough for the whole community. Issues with regards to maintenance of the facility.	Enough storage facility should be distributed in the communities

<b>Institution</b>	<b>Description</b>	<b>Achievements</b>	<b>Challenges</b>	<b>Way forward</b>
NGO(CIKOD)	Farmers were taught how to make composting (Gozire, Zidung and Betanglu)	Supported farmers through the provision of improved seeds in 2015 Monitored on the success of the seeds in 2017	One crop variety is provided at a time. This is not enough to support household income	Different crop variety should be given to farmers
Local institution (Chief)	Call for meeting to find out issues with the community with regards to climate change	Sensitize communities about relevant information (e.g. climate change)	Language barrier: Sometimes translators use English words to give explanations which is difficult to understand especially if the things explained are not tangible. Distortion of information before it gets to the final listener	Similar words in the language should be used explanation

MoFA- Ministry of Food and Agriculture; CIKOD- Centre for Indigenous Knowledge and Organizational Development;

VSLA- Village Savings and Loans.

## **CHAPTER FIVE**

### **DISCUSSION**

#### **Socio-demographic characteristics of smallholder farmers**

The type of religious belief affected the understanding of climate change risks of some farmers. This was clear in an interview with a contact person in Orbilli, a secondary school graduate who told us about the observed changes in recent weather/climate and related them to the rarity of sacrifices to the gods. The churches in the communities are based on the orthodox beliefs which were mainly Catholics with only few Methodist churches. Unemployed respondents in the Orbilli community were individuals who had no farmlands to farm and were older than 60years. This age cohort was dependent on other family members for their livelihoods. The greater numbers of residents in households indicate high dependence on existing farmlands since farming products will cater for more 'mouths'. Ownership of houses is through distribution of family properties which are partly rented to foreigners (those who are not indigenes of the community). This type of household is mainly occupied by extended family members (aunts, uncles, and grandparents).

#### **Perceptions of smallholder farmers about climate variability/change**

Decisions people make towards climate change adaptation is based on their perceptions about climate change and its likely impacts. The rise in temperatures and unpredictable rainfall is obvious across all ecological zones in the country from 1961-2000 (for example IPCC, 2001). In this study, high temperatures together with low and irregular rainfall pattern were experienced by farmers in all the six communities. This was particularly evident among the older farmers who have worked on the farmlands of Lawra and Nandom Districts for more than 20 years.

In contrast, analyses of rainfall data show a slight increase over the years and decrease in temperature within the Guinea savannah areas. The results however show an inter-annual variability in the climate data (especially in rainfall). Perhaps, the perception of reduced rainfall is based on the variability of rainfall within the growing season rather than annual change (for example Fosu-Mensah *et al.*, (2012)).

Surface water and underground water levels are directly affected by temperature and rainfall. This means that, surface water (in this case the Black Volta River) is expected to fall given the false assumption of a decreasing rainfall and increasing temperature respectively. However, the Ghana Meteorological data on rainfall obtained from Soil Research Institute (SRI) shows a slight increase in rainfall. This could be a contributory factor to the increase in the flow of the Black Volta River between 1951-2003. For example, Yeboah *et al.* (2013) argue that, the Black Volta has a high tendency to provide a reliable and sustainable source of water supply for domestic, agricultural and industrial uses even under climate change.

In addition, knowledge acquisition, information flow and sharing are quite limited in northern Ghana (Schiffer *et al.*, 2008; Padgham *et al.*, 2015). The government agencies provide climate change information to local farmers through the limited numbers of the extension officers. These officers pass on the information to contact persons in the communities, the chief or farmer group associations. This mode of information transfer affects the quality of information received by the local farmers. Access to extension officers is one of the four main reasons mitigating against climate change adaptation measures (Fosu-Mensah *et al.*, 2012). The Environmental Protection Agency of Ghana (EPA) with its knowledge and information on climate change does not interact with the radio stations or the planning officers at the local level to provide in-depth knowledge about climate change to farmers (for example Padgham *et al.*, 2015).



## **Climate change impacts on agricultural livelihoods**

The climate of an area determines the type of crop grown at the area. This can mean that, changes in the climate variables (temperature and rainfall) in an area will affect crop production in that area. The soils are now harder than it used to be lamented an elderly man in Berwong. He added that “...*we tend to believe that our hoes now are heavier than us as we fall on our farms in an attempt to plough*”. Berwong is the only community that experience decrease in food and clothing over the last 10years. Decrease in the education of children was also observed in Berwong and Betanglu. These are the two communities that have not consciously developed efforts towards adapting to climate change adaptation. However, Betanglu community during the survey, showed that the community is now copying the climate change adaptation initiatives such as zero tolerance to bush burning and deforestation among others by its neighbouring community- Gozire. Interaction with some government agencies and NGOs suggested that, it was easier to work with communities who have developed or started some strategies towards climate change adaptation than communities that have not developed any local initiative towards climate adaptation. The increase in food and clothing experienced in the other communities was attributed to the introduction of new seeds/improved seeds such as groundnuts, maize and Dorado and the use of fertilizers/compost through the extension officers and contact persons to farmers by MoFA and CIKOD. This has influenced crop production in the last 10 years by farmers in those communities. Interestingly, in a FGD at Berwong, discussants argue that even though they have observed some increase in crop production for some time now through composting, the food variety remains the same. They added that the improved maize seeds were only available to farmers who could purchase them and not all farmers are able to buy the technology. The increase in crop production (75%) and diversification to non-farming income (such as petty trading and construction works) (20%) has resulted in a slight increase in the income levels

(51%) in five communities (except Berwong) in the last 10 years. This increase has a trickled-down effect on the food and clothing usage by the farmers in the communities. That is, the ability to buy more food and clothing among others was dependent on the rise in income level of the farmer. The launch of the National Health Insurance Scheme (NHIS) has increased the use of government hospitals and reduced the cost incurred in seeking medical attention.

The major animals reared in the six communities were pigs, sheep, cattle and poultry. They are vulnerable to any change in climate unlike goats which are more resistant to drier weather conditions (Feleke *et al.*, 2016). In this regards, MoFA presented one goat to each female farmer in Zidung as a way of empowering women in that community.

### **Climate change adaptation by institutions among farmers**

Adaptation to climate change was dependent on how farmers perceive and relate to climate change risks. Changing of planting dates is the main adaptation strategies by farmers in all communities. Adoption of new crop varieties is the next adaptation strategy farmers engage in due to the change in weather/climate in the communities (except Berwong which has seasonal migration). Farmers in Berwong (especially female farmers) will rather migrate to Burkina Faso to cut firewood and sell rather than agricultural adaptation measures. Farmers in Berwong lament about their inability to adequately adapt to climate change agricultural adaptation is due to the lack of understanding about climate change risks and climate change adaptation strategies as well lack of access to financial resources.

However in Gozire, the community minimized deforestation and bush fires as a way to control and maintain the soil quality under the changing climate. This manifested as an increase in the crop yields and the general livelihood of the people. Most of the adaptation measures are firstly initiated by the farmers and supported by external agencies. Thus,

external agencies first consider local initiatives present in a community before they provide their support. An interview with Lawra's technical personnel of the Environmental Protection Agency (EPA) suggests that, '*communities*' that have developed initiatives towards climate change adaptation have the tendency to attract government agencies and NGOs to provide assistance towards the implementation of those strategies. For instance, '*Kanpuoh had assistance (borehole and milling factory) from MoFA, Ghana Environmental Management Project (GEM Project) and Food and Agriculture Organization (FAO) among other institutions because of the community's initiative towards zero tolerance to deforestation and bush burning.*' This observation contrasts the findings of Padgham *et al.* (2015) which reports that, external agencies implement adaptation strategies without considering community input and local protocols. Hence such programmes do not sustain after the project term.

Knowledge and information transfer was mostly carried out by the NGOs than government agencies. The information dissemination was most times done at the inception of a project by these organizations at a durbar or at the chief's palace. Government agencies even though provide knowledge and information has an inadequate number of extension officers as has been discussed earlier. Technical support through the training of farmers on soil conservation, composting and VSLA is done by government agencies in all the communities. In addition, financial support was also provided by the NGOs in Orbilli and Zidung communities. The study also revealed that government-led programmes towards climate change adaptation seem to be more sustained in all the communities including Berwong. This is largely due to the fact that government-led programmes targets larger population in the communities as compared to NGO-led programmes. In addition, there government-led programmes are occasionally monitored by the extension officers in the communities. For instance, the community still uses the composting techniques acquired from MoFA through the extension officers in 2012 to date. However, there is also effective monitoring by the NGOs on the

success of a programme in communities involved until the closure of that project. For instance, during the survey at Gozire, CIKOD had visited the community to check on the progress of the new groundnut seeds given to farmers in 2015. The NGO-led programmes appear to be taking up the 'adaptation space; from governments in both districts in the aspect of information and knowledge transfer and financial support.

The traditional authorities are decision makers in the communities and are concerned with the conservation of natural resource management. Severe sanctions are imposed on law breakers who burn trees or start wildfires. The survey showed that there were more local institutions in Lawra than in Nandom, however, bush burning and deforestation seems to be higher in Lawra than in Nandom.

There is however, cooperation, compliance and dedication between local protocols and external agencies in the implementation of climate change adaptation in communities. Chiefs and representatives of farmers associations interact with some formal institutions (such as MoFA and Esoko) to gain further insights about climate change agricultural adaptation strategies in order to educate other farmers.

## CHAPTER SIX

### CONCLUSION

Changing of planting dates (100%), planting of different varieties of the same crop (10%), planting of trees (43%) and seasonal migration (21%) are major responses of smallholder farmers to perceived impacts of irregular and unpredictable rainfall, rainfall ceasing during growing season and delayed onset of rains. NGOs (Care International, CIKOD, and ESOKO), government agencies (MoFA and NADMO), research institutions, chiefs and farmers group associations are the main institutions in the communities studied. The formal institutions mainly support climate change agriculture adaptation through the provision of early warning information (84%), technical knowledge (91%), and financial support (although negligible) (2%) to smallholder farmers at varying scales. The major barriers are the inadequate financial capacity and skilled personnel to sustain on-going climate change adaptation strategies among farmers. Despite the lack of planned interventions in some communities such as Betanglu, farmers are learning from other communities that have, zero tolerance to bush burning in Zidung and Gozire. Informal institutions, on the other hand, mainly enforce laws on natural resource management and conservation and provide available information to farmers (15%). Smallholder farmers' ability to adapt is hindered by lack of information about the risks associated with climate change and lack of access to financial resources.

Communities that do not develop initiatives towards climate change agricultural adaptation will remain poorer and incapacitated to face future climate change risks, as there are no agencies to invest in them.

## **RECOMMENDATION**

Interventions facilitated mainly by MoFA are therefore needed in these communities in order to bridge the poverty gap between communities and avoid potential future conflicts over access to dwindling resources. With the growing overdependence on foreign/external support in the communities that have already developed adaptation initiatives, there is a risk of negative impacts on new innovations by the farmers.

NGOs should concentrate on building farmers capacity that will lead to sustained implementation of strategies long after the NGO programme/project ends. Capacity building can be supported through training of radio/TV journalists about climate change risks and impacts. The NGOs could also pay for airtime at the radio stations to speak on climate change issues. Student researchers can also educate farmers on climate change as they interact with them on their farmlands. This will help in efficient dissemination of quality climate information to and among farmers.

In addition, relevant findings from research institutions should be provided to the District Assemblies and chiefs' palaces in user friendly format such as posters or fliers. This will serve to educate farmers on new research being carried out and can also be easily communicated to the community members during durbars or festivals.

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## APPENDICES

### Appendix A: Household questionnaire

The investigator is a research student at the Institute for Environment and Sanitation Studies (IESS) at the University of Ghana. The research is aimed at identifying and evaluating how formal and informal institutions implement agricultural adaptation strategies for smallholder farmers in the Lawra and Nandom Districts. Response from the questionnaire will be treated confidentially and will not be released to any third party under any circumstances.

#### Section A: Demographic Characteristics

Locality name..... District..... Date:

- 1) Sex:      a) Male                  b) Female
  
- 2) Age:      a) 20 – 29                  b) 30 – 39   
              c) 40 – 49                  d) 50 – 59              e) 60 and above
  
- 3) Religious Affiliation:  
  
              a) Christianity     b) Islam              
              c) Traditional        d) Other
  
- 4) Education  
  
              a) No formal education     b) Basic education      
              c) Secondary education        d) Vocation            e) Tertiary
  
- 5) Marital status  
  
              a) Single                        b) Married              
  
              c) Divorced                        d) Widowed

6) What is your current occupational status?

- a) Civil servant..... [ ]      b) Self-employed.....[ ]
- c) Unemployed                                  [ ]      d) Retired                                  [ ]
- e) Unable to work                              [ ]      f) Student                                  [ ]
- g) Others.....

7) Which kind of income do you receive? (Select all that apply)

- a) Earning from (self) employment [ ]    b) Rent                                      [ ]
- c) Pension pay                                      [ ]    d) Family                                      [ ]
- e) Others .....

8) How will you rate your household income?

- a) Usually not enough to cover important household expenses [ ]
- b) Just enough to cover important household expenses [ ]
- c) Usually have some left after important household expenses [ ]
- d) Other (specify) .....

9) What type of housing do you live in?

- a) Rented    [ ]                                  b) Own house                                  [ ]
- c) Family home [ ]                                  d) Others                                      [ ]

Specify.....

10) Including yourself, how many people are in your household?

- a) 1-5    [ ]                                  b) 6-10    [ ]

c) 11-15 [ ]      d) 16-20 [ ]      e) Above 20

[ ]

10)b. How many people are below 18years..... above  
18years.....

**Section B: Perceptions about Climate Change and variability**

11) Have you heard the term climate change?

a) Yes (If yes skip to question 14) [ ]

b) No (If no go to question 12) [ ]

12) If “No”, have you observed any changes in temperature over the past 10 years?

a) Increasing [ ]      b) Decreasing [ ]

c) Stayed the same [ ]      d) Don't know [ ]

13) If “No”, have you observed any changes in rainfall pattern over the past 10 years?

a) Changes in the timing of rainy season (specify)..... [ ]

b) Less rainfall [ ]      c) Heavy rainfall [ ]

d) None of the above [ ]      e) Haven't noticed [ ]

14) If “Yes”, how do you understand climate change?

.....  
.....  
.....  
.....

15) If “Yes”, please specify by ticking (✓) in each of the row where you heard about climate change

<b>Sources of climate-related knowledge</b>	<b>Tick if applicable</b>	<b>Specify with names</b>	<b>Please describe how you use this information</b>
The media (i.e. television, radio, newspapers)			
Internet sources			
School/Teacher			
Climate scientist/experts			
Community leaders			
Family and friends (Peer group)			
Government information			
An environmental organisation (e.g. Friends of the Earth-Ghana)			
Place of worship			
Other (specify)			

16) Please tick (✓) in each row to indicate how much you would trust information about climate change if you heard it from;

<b>Sources of climate-related knowledge</b>	<b>A lot</b>	<b>A little</b>	<b>Not very much</b>	<b>Not at all</b>	<b>Can't choose</b>
The media (i.e. television, radio, newspapers)					
Internet sources					
School/Teacher					
Climate scientist/experts					
Community leaders					
Family and friends (Peer group)					
Government information					
An environmental organisation (e.g. Worldwide Fund for Nature)					

Place of worship					
Other (specify)					

17) How important is the issue of climate change to you personally?

- a) Very important                        (go to question 18)
- b) Quite important                        (go to question 18)
- c) Not very important                    (go to question 19)
- d) Not at all important                  (go to question 19)

18)            Why                    is                    it                    important                    to  
you?.....  
.....  
.....  
.....

19)            What                    do                    you                    think                    causes                    climate  
change?.....  
.....  
.....  
.....

20) Do you think climate change is something that is affecting or going to affect you, personally?

- a) Yes

b) No

[ ]

c) Don't know [ ]

21) For any answer above,

Why?.....

.....

22) What are the possible changes in the climate that may affect your community in the next 5-10years? Please tick (✓) in each row to indicate if applicable;

Possible changes in climate	Tick if applicable	Specify the change
Delay in onset of rains		
Early rains		
Irregular and unpredictable rainfall		
Rainfall associated with storms		
Rainfall associated with floods		
Rainfall will generally decline		
Rainfall will generally improve		
Rainfall will sometimes cease during growing season		
Early cessation of wet season		
Late cessation of wet season		
Clouds will bring more winds than rain		
Extreme dry season		
High temperature and extreme heat		

None		
Other specify		

Type of production	Increase	Decrease	No change	Reason
a) Crop production				
b) Livestock production				
c) Mixed production				
d) Other, specify.....				

**Section C: Impacts of Climate Change on Agriculture and Livelihood**

23) What have you observed in your agriculture production over the last 10years? Please specify by ticking (✓) in each row:

24)Please indicate how much you agree or disagree with the following statement about climate change by ticking in each row:						
	<b>Strongly agree</b>	<b>Agree</b>	<b>Not sure</b>	<b>Disagree</b>	<b>Strongly disagree</b>	<b>Reason</b>



<p>a) The changes in the last 10years has increased my income level</p>						
<p>b) The changes in the last 10years has decreased my income level</p>						
<p>c) The changes in the last 10years has had no change on my income level</p>						
<p>d) Income from agriculture over the last 10years has been enough to cater for my family's needs</p>						
<p>e) The changes experienced in the weather over the last 10years is</p>						

due to climate change/variability						
--------------------------------------	--	--	--	--	--	--

25) Please indicate how changes over the last 10years have affected your family's living standard in the following areas by ticking (√) in each row:				
	<b>Increased</b>	<b>Decreased</b>	<b>No change</b>	<b>Reasons</b>
a) Food/clothes				
b) Education of children				
c) Housing and electricity/water				
d) Health care				
e) Transportation				

**Section D: Adaptation Strategies**

26) Are you currently engaged in an activity (ies) because of the changing climate?

a) Yes [ ]

b) No [ ]

c) Don't know [ ]

27) If "Yes", what influenced your decision to engage in any activity(ies) in response to climate change/variability?

- a) Self-motivation [ ]      b) Income level [ ]
- c) Size of farmland [ ]      d) Number of household members [ ]
- e) Level of Knowledge [ ]      f) Access to credit facilities [ ]
- g) Others [ ] Specify.....

28) If “No” is your decision not to engage in activity in response to climate change as a results of

- a) Lack of knowledge about adaptation strategies [ ]      b) Lack of capital [ ]
- c) No access to credit facilities [ ]      d) Number of household members [ ]
- e) Others [ ] specify .....

29) Please indicate which of the following practices you engage in by ticking (√) in each row:

<b>Adaptation strategies</b>	<b>Tick if applicable</b>	<b>Duration of practice</b>	<b>Reasons</b>
a) Planting of short season crops			
b) Planting crops resistant to droughts			
c) Changing planting dates			
d) Planting trees			

e) Irrigation of farmlands			
f) Others			

30) Please indicate by ticking (√) in each row the adaptation practices that your community is engaged in:			
<b>Adaptation practices/strategies</b>	<b>Tick if applicable</b>	<b>Duration of practice</b>	<b>Reasons</b>
a) Diversify from crops to livestock and between different types of livestock			
b) Crop diversification from single to multiple crops			
c) Change of planting dates			
d) Diversify to non-farm income sources			

e) Adopt different varieties of the same crops			
f) Water-stress-related migration			
g) Change seasonal migration patterns			
h) Change to different cultivation or grazing sites			
i) Investment in soil conservation			
j) Change between surface and groundwater irrigation investment in water conservation and rainwater harvesting			
k) Change seasonal water use patterns			

1) Others;			
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31) Please indicate by ticking (√) in each row the adaptation practices that are planned in your community:				
<b>Adaptation measure</b>	<b>Implemented</b>	<b>Planned</b>	<b>Not yet planned but necessary</b>	<b>Not Relevant</b>
a) Diversify from crops to livestock and between different types of livestock				
b) Crop diversification from single to multiple crops				
c) Change of planting dates				
d) Diversify to non-farm income sources				

e) Adopt different varieties of the same crops				
f) Water-stress-related migration				
g) Change seasonal migration patterns				
h) Change to different cultivation or grazing sites				
i) Investment in soil conservation				
j) Change between surface and groundwater				

irrigation investment in water conservation and rainwater harvesting				
k) Change seasonal water use patterns				
l) Others;				

32) Did you get support in any of the following adaptation areas? Please indicate by ticking (✓) in each row;			
	<b>Past</b>	<b>Present</b>	<b>Please specify with year and name of institution</b>
Fertilizer Subsidies			
Mechanized subsidies			
Micro-financing/investment support			
Procurement of agricultural products			



Support to rural households			
Others (state)			

**Section E: Institutions and their roles**

33) Please indicate by ticking (√) against the institution (s) in your community.				
<b>Name of institution</b>	<b>Tick if available</b>	<b>Specify</b>	<b>Expected roles in the community</b>	<b>Actual roles in the community</b>
Government Agencies(MoFA, State agricultural extension services etc )				
NGOs (NANDIRDEP, ESOSKO, Oxfam, CARE etc)				
Research Institution				
Local institution (Chieftaincy, Producers' Association)				
Others, Specify.....				

34) What are their roles in the implementation of adaptation strategies in your community? Please tick (✓) in each of the row applicable;

<b>Name of institution</b>	<b>Provide technical support</b>	<b>Transfer Knowledge and information</b>	<b>Provide financial support</b>	<b>Others, specify</b>
Government Agencies(MoFA, State agricultural extension services etc )				
NGOs (NANDIRDEP, ESOSKO, Oxfam, CARE etc)				
Research Institution				
Local institution (Chieftaincy, Producers' Association)				
Others, Specify.....				

35) Please indicate how much you agree or disagree with the following statement about institutions and implementation of climate change adaptation by ticking (✓) in each row:

	<b>Strongly agree</b>	<b>Agree</b>	<b>Not sure</b>	<b>Disagree</b>	<b>Strongly disagree</b>	<b>Why</b>
a) The						

institutions provide early warning systems for drought						
b) The institutions improve land use in agriculture: crop substitution and diversification						
c) The institutions have improved agriculture practices that reduces runoff						
d) The institutions have improved water use efficiency in						

agriculture sector						
e) The institutions endure the development of non-farm livelihoods in drought/flood affected areas						
f) Others;						

**Appendix B: Interview Guide for Personnel from the Institutions**

*The objective of this instrument is to assess the roles of institutions in the implementation of climate change adaptation strategies in the District*

Locality: ..... District: ..... Date  
.....

**Section A: Demographics**

1) Sex: ..... 2) Age: ..... 3) Name of institution:  
.....

4) ..... Name ..... of ..... respondents  
(optional).....

5) Occupation: .....

6) How long have you been in this community? .....

7) How long have you been working in this institution?

**Section B: Existing problems**

8) What are some of the problems the people in the communities face over the past 10years?

(List/ Rank)

9) Have those problems changed over the years? What the causes of these problems?

10) Do you know how the communities have managed/ managing with those problems?

11) Have those problems affected their way of life (what they eat, social groups, health care)?

How?

12) Has your institution done/ doing anything o help solve the problem?

**Section C: Climate Change Perception**

13) Have you heard about climate change?

14) Where did you hear it from?

15) What about climate change did you hear?

16) When will the impacts of climate change have impacts on your institution?

a) It has already had an impact

b) In the next 1-5years

c) In the next 5-20 years

d) In more than 20 years

e) Not in the foreseeable future

f) I do not know

17) When will the impacts of climate change affect your community?

a) It has already had an impact

b) In the next 1-5years

c) In the next 5-20 years

d) In more than 20 years

e) Not in the foreseeable future

f) I do not know

18) What do you see as the most relevant next steps for your company in assessing climate risk?

a) Engaging with other key groups to build consensus on sector-wide initiatives

b) Developing specific adaptation actions

c) Assessing and analyzing current data to make effective adaptation plans

d) Engaging with community and public sector stakeholders

e) Other

#### **Section D: Adaptation and Institution roles**

19) Is your institution engaged in activities in relation to climate change adaptation?

20) What are some of the activities your institution is engaged in?

21) Have these activities helped to raise the income level of the people in the community?

22) Have these activities changed the living standard of the people in the community?

- 23) What are some of the benefits the community derives from the institution?
  
- 24) What are some of the challenges the institution face in relation to these activities?
  
- 25) What do you think can be done to curb some of these challenges?

**Appendix C: Interview Guide: Key Informant**

*The objective of this instrument is to assess the roles of institutions in the implementation of climate change adaptation strategies in the District*

Locality name..... District..... Date .....

**Section A: Demographics Characteristics**

- 1) Sex:    2) Age:
  
- 3)    Name    of    respondents  
(optional).....
  
- 4) Occupation: .....
  
- 5) How long have you been in this community? .....

**Section B: Perception about climate change and variability**

- 6) Have you heard about climate change?
  
- 7) Where did you hear it from?
  
- 8) What about climate change did you hear?

**Section C: Impacts of Climate Change on Agriculture and Livelihood**

9) What have you observed in your agriculture production over the last 10years?

10) Has the observed changes affected your income level?

11) Has it affected your expenditure level?

#### **Section D: Climate Change Adaptation**

12) Are you currently engaged in any activities because of climate change?

13) What are some of the activities you are engaged in currently?

14) What influenced your decision?

#### **Section E: Institutions and their roles**

15) What are the institutions in your community?

16) Are these institutions supporting any climate change adaptation in your community?

17) What are some of the activities (climate change adaptation) the institutions have helped the community in?

18) Do you think the institutions have helped the community in such activities (climate change adaptation?). Why?

19) What do you think can be done to help improve the roles of the institutions? Local and national level.



## **Appendix D: Focus Group Discussion**

*The objective of this instrument is to assess the roles of institutions in the implementation of climate change adaptation strategies in the District*

Locality name:..... District..... Date:

Total number.....

Males..... Females..... Age  
range.....

### **A. Agriculture and Livelihoods**

1. What are some of the factors/problems that affect you as farmers? Find out if they can rank them. What are the causes of these problems?
2. Are those problems the same you faced over the last 10years? Find out the reasons for the change if the problems are different over the years.
3. Are the problems you face affected your way of living (What you eat, wear, healthcare, social groups) over the last 10years? How has it?
4. Are there some good experiences you have enjoyed over the last 10years as farmers? Can they rank them?

### **B. Climate change/variability knowledge**

5. Are there some changes observed in the weather/climate over the last 10years?
6. What are some of the changes?
7. Have you heard about climate change?

8. Where did you hear it from?

9. What did you hear about climate change?

10. What are the causes of climate change?

11. Is climate change your biggest problem as farmers in this community?

### **C. Climate change Adaptation**

11. What are the major crops grown in this community? Are they the same crops grown over the last 10years? Are there reasons for the change in the types of crops grown over the years?

12. Are there specific times these crops are grown in the year (i.e all year round, once in a year etc)?

13. Are there some activities that the communities engage in with respect to the changing climate?

14. What are some of the activities? Can they rank the activities based on the dominance?

15. Where those activities supported financially, technical support or knowledge dissemination.

### **D. Regeneration and Composting**

16. What is regeneration/Composting?

17. When did it start?

18. What are some of the trees grown in the conserved land? Local names of the trees

19. Have the tree type changed over the last 10years?

20. What influenced your decision of the type of tree?

21. What type of compositing do you do? Why?

**C. Institutions**

22. What are some of the institutions in these communities?

23. What are the roles they play towards climate change adaptation in this community?

24. What are some of the successes and challenges the institutions face in the implementation of climate change adaptation?

25. What are some of the suggested recommendations for the institutions?

## Appendix D: Additional Results

**Table 8: Total number of people in Household**

<b>Number</b>	<b>Frequency</b>	<b>Percentage</b>
1-5	48	35.6
6-10	66	48.9
11-15	18	13.3
16-20	3	2.2
<b>Total</b>	<b>135</b>	<b>100</b>

**Table 9: Marital Status of farmers**

Single	6	4.4
Married	108	80.0
Widowed	21	15.6
<b>Total</b>	<b>135</b>	<b>100</b>