NEGLECTED AND UNDERUTILIZED CROP SPECIES (NUCS) AND HOUSEHOLD FOOD SECURITY IN CENTRAL GHANA

THIS THESIS IS SUBMITTED TO THE UNIVERSITY

OF GHANA, LEGON

IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF PHD IN ENVIRONMENTAL SCIENCE DEGREE

BY

BAA-POKU FRIMPOMAH: 10191615

JULY, 2019

DECLARATION

I, Frimpomah Baa-Poku hereby declare that except for references to the works of other researchers, which have been duly acknowledged, this thesis was carried out entirely by myself and has neither in whole nor in part been presented for another degree in the University of Ghana or any other institution.

……
BAA-POKU FRIMPOMAH
(STUDENT)

DATE: ……

……
PROF. ISAAC K. ASANTE
(PRINCIPAL SUPERVISOR)

DATE: ……

.....……....
DR. JESSE S. AYIVOR
(SUPERVISOR)

DATE: ……..

.....…….....
DR. BENJAMIN D. OFORI
(SUPERVISOR)

DATE: ……

DEDICATION

This study is dedicated to my dear husband, Jeffrey Baa-Poku for his love and support that urged me on. To my parents, Arch. Joseph Nkrumah Asante and Mrs. Mary Agyare Asante; and siblings, Jude, Albert, Gyamfua and Dor for going the extra mile with me throughout my study.

ACKNOWLEDGEMENT

First, to thank God Almighty for His blessings and also for keeping me throughout my study. To IESS, University of Ghana, then to the Management and Staff respectively of Koforidua Technical University for approving my application for further studies and granting me all the necessary support. To my supervisors Prof Isaac K. Asante, Dr. Jesse S. Ayivor and Dr. Benjamin D. Ofori for their encouragement and thought-provoking feedback. Their guidance and useful suggestions brought clarity and focus to the study. I also wish to express my profound gratitude to the following: my respondents – farmers, market women, FBOs; Chiefs and people of Upper Afram and Upper Dayi study sites for allowing me entry into their communities; CRI-CSIR at Ejura especially Mr. F. C. Danso; PGRRI-CSIR at Bunso especially Dr. L. M. Aboagye; MoFA officials in Hohoe and Ejura, EPA Koforidua, especially Mr Felix Addo-Kyere; Agricultural Extension Officers in my study communities especially Emmanuel Addo and Divine; and to Mr. Emmanuel Tetteh and Mr. George Asare for assisting with the statistical analysis and finally all friends and loved ones who prayed with me and urged me on.

ABSTRACT

The gradual erosion of indigenous crop varieties and its negative effect on agrobiodiversity, agricultural systems and food security remains a major challenge globally. In Ghana, agricultural systems now emphasize on the cultivation of selected high yielding crops to the neglect and subsequent marginalization of indigenous food crop varieties and plant species, for reasons that have not attracted much research attention. This study therefore sought to profile the varieties and uses of neglected and underutilized crop species (NUCS) and plant species in the Upper Afram and Upper Dayi basins of the middle belt of Ghana and examine the factors influencing their erosion and marginalization, as well as, the possible implications for household food security at the local level. The study employed both qualitative and quantitative research approaches to explain the experiences of about 271 respondents in relation to the eroded and marginalized food crop varieties and the constraints hindering their cultivation and use. Climatic data and satellite imagery analysis were used to determine longitudinal changes in climatic and land use and land cover over time respectively, and how these may have affected the erosion of these crop varieties. The data were analyzed qualitatively based on the themes emanating from the interviews and quantitatively using descriptive statistics and results presented in the form of percentages, frequencies and tables. Findings of the study confirmed the neglect and marginalization of a variety of the indigenous food crops in the middle belt of Ghana, though a total of 112 of such neglected and underutilized crop varieties (belonging to the food crop categories: cereals, legumes, vegetables, roots and tubers, tree crops, and fruits) were identified and very rare. Factors responsible for the erosion include indiscriminate use of agro-chemicals, climate variability and environmental change particularly forest cover. The study further revealed that socio-economic factors namely market demand and dietary habits have also

contributed immensely to the marginalization of these crops. These notwithstanding, certain traditional practices and customary rites have helped in the preservation of some of these indigenous food varieties whose cultivation still dominate certain areas. The findings concluded that the erosion and marginalization of these food varieties among the rural communities may be responsible for the current food insecurity in the study communities compared to the past. These findings create the need for a review of the policy strategies of the country as outlined in the Food and Agriculture Sector Development Policy (FASDEP II) to integrate NUCS especially given their known contribution to the attainment of food security among rural households. Finally, the study recommends the relevant Ministries, Departments and Agencies (MDAs) such as the Local Government, Ministry of Tourism, Ghana Tourism Authority, Ministry of Culture, among others, to institute regular indigenous food fairs at the local (village), district and regional levels, to promote local dishes which are prepared with these neglected and underutilized crop varieties.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LIST OF ABBREVIATIONS

CFSVA	Comprehensive Food Security and Vulnerability Analysis
CRI	Crops Research Institute
PGRRI	Plant Genetic Resources Research Institute
FAO	Food and Agriculture Organisation
FSTZ	Forest Savanna Transition Zones
FASDEP	Food and Agriculture Sector Development Policy
IPGRI	International Plant Genetic Resource Institute
IFPRI	International Food Policy Research Institute
LULC	Land use and land cover
MoFA	Ministry of Food and Agriculture
NUCS	Neglected and Underutilised Crop Species
RBT	Resource-based Theory
SDFZ	Semi-Deciduous Rainforest Zone
SDG	Sustainable Development Goal
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UAB	Upper Afram Basin
UDB	Upper Dayi Basin
WFP	World Food Programme

CHAPTER ONE

INTRODUCTION

1.0 Background

Human reliance on the diversity of plants and animals for survival dates back to prehistoric times. Until the early parts of the twentieth century, traditional farmers cultivated and relied on a wide range of indigenous crop varieties and livestock breeds to achieve food security and enhance human livelihood (Stefanie & Amend, 2008). Agricultural biodiversity as espoused by Biodiversity International involves the deliberate consideration and use of the diversity and variability of plants, animals, landscapes, soil organisms among others, to achieve certain goals including food security (Bioversity International, 2017). Azam-Ali (2010) however notes that the genetic diversity sustaining agriculture has declined globally.

Modern agricultural systems now place emphasis on the cultivation of high-input and high-yielding crop species, a situation that has resulted in the increased dependence on a few priority crops such as rice, wheat and maize (Lopez-Noriega *et al.,* 2017). This has led to the marginalization and erosion of some indigenous crops and plant species. Even though over 30,000 plant species are edible to human kind and about 7000 are grown or collected for food, only 30 staple crops currently feed the world (FAO, 2017). Increasing globalization and changes in lifestyle are among some of the factors that have been attributed to this paradigm shift in agriculture (Hawtin, 2007). This current development and its attendant effects on agrobiodiversity is a source of growing concern.

According to Chivenge *et al*. (2015) the cultivation of indigenous crops and plant species also referred to as Neglected and Underutilized Crop Species (NUCS), can provide greater genetic biodiversity and also potentially improve food security. Additionally, NUCS contribute to maintaining cultural diversity among indigenous communities due to the cultural value they place on them (IPGRI, 2002). Thus, NUCS constitute an important component of agrobiodiversity.

Conceptually, it is difficult to precisely define which attributes make a crop "underutilized" due to the multiplicity of the factors influencing the less use of such crops and species. Azam-Ali (2010), defined NUCS as crops that have hitherto not been categorised as major crops, have not had much research carried out on them, are not being used in a major way at present and are largely restricted to smallholder farming areas. In this study, Azam-Ali's (2010) conceptual definition of NUCS is adopted and, therefore, NUCS is defined as crops and species that have not been categorised as selected or key staple crops and are not being used in a major way at present and are largely restricted to local farmers and rural households.

NUCS occur widely in both temperate and tropical regions including Sub-Saharan Africa; Latin America; and South and East Asia (Padulosi *et al*., 2013). Increased use of NUCS as source of food and medicine has been reported in Asia and the Pacific particularly in countries such as Malaysia, Nepal, India and the Philippines. In Sub Saharan Africa, the cultivation and use of NUCS is common in countries such as Malawi, Nigeria, Cote d' Ivoire, Uganda, and Zimbabwe (Padulosi *et al*., 2013; FAO, 2010). Among the categories of food crops that NUCS can be found or belong to include legumes, roots and tubers, fruits, vegetables, nuts, cereals, pseudocereals, oilseeds, aromatic and medicinal plants (Padulosi *et al*., 2004, 2008). Examples of NUCS found

in Sub Saharan Africa include *Amaranthus sp.* (Laker, 2007); wild mustard (*Brassica* spp.) and other wild edible leafy vegetables (Modi *et al*., 2006). Others include taro (*Colocasia esculenta*); sweet potatoes (*Ipomoea batata*); bambara groundnut (*Vigna subterranea*) and wild melon (*Cucurbita* spp). In Ghana, Aboagye *et al*. (2010) note that there is diversity of NUCS that can be useful in plant breeding programmes, including *Vigna reticulate,* wild yam, wild oil palm, and most medicinal plants such as mahogany (*Khaya senegalensis*) and *Rauwolfia vomitoria*.

NUCS possess several useful and beneficial traits that make them important to the environment and human livelihood. Even though the cultivation of NUCS often produce lower yields compared to the major staple crops, they are relatively more resistant to biotic challenges and are therefore able to adapt to harsh climatic conditions such as poor soils and drought (Padulosi *et al*., 2013). Environmental concerns such as land use changes; the impact of climate change; and the degradation of land and water resources among others have led to a growing interest in NUCS (IPGR, 2002). Their ability to thrive under harsh climatic conditions makes them valuable and key in the fight against the negative impact of climate change on agricultural food production (Bala Ravi *et al.*, 2006). NUCS also offer good alternative in the event of failure of the main staple crops to survive under such harsh conditions (Mabhaudhi, *et al*., 2011). Apart from their medicinal value, some NUCS also contain high levels of vitamin B_2, and vitamin C and proteins which are used as substitutes to conventional vegetables in human diet (Mengistu and Hager, 2008).

According to the FAO (2016), the livelihood of about half of the world's population depends on food security, yet, in recent times, there has been increase in food insecurity. This has implications for the achievement of the Sustainable Development Goal (SDG 2) which seeks to

achieve food security and improved nutrition through sustainable agriculture. In Ghana, the Ministry of Food and Agriculture, MoFA (2015) noted that five percent of the population (1.4 million people) is food insecure; with the rural households in the three Northern regions being the most affected compared to the urban areas (WPF, 2012).

Neglected and underutilised crop species (NUCS) historically have contributed to ensuring household food security among indigenous communities while creating income generating opportunities for small holder farmers as well (Mabhaudhi *et al*., 2011). Several studies including those by Muhammad (2014); Sprent *et al*. (2009); Bhattacharjee (2009) among others have all pointed to the important benefits of NUCS and their role in contributing to the achievement of food security.

While research efforts and government interventions continue to be directed towards addressing food insecurity in Ghana, there seems to be limited empirical research and documentation of neglected and underutilized plant species and their potential to enhance food security. This is evidenced by the 2013 Accra Statement for a food secure Africa report, which identified most countries in Africa including Ghana as pursuing agricultural and food policies based on a limited number of crops or staples. This study therefore seeks to explore the diversities and potential contribution of such neglected and underutilised crops and species (NUCS) in addressing food security among rural households in the Upper Afram and Upper Dayi basins in the middle belt of the country.

1.1 Problem Statement

The decline in agricultural biodiversity and its adverse effect on sustainable agriculture and food security continues to be a major challenge globally (Jacobsen *et al.,* 2013; Chappell & LaValle, 2011; Toledo & Burlingame, 2006). This growing concern about the erosion of agrobiodiversity is also captured by the Sustainable Development Goal (SDG 2) which seeks to stress the need for the maintenance of genetic diversity and the utilization of genetic resources for food security. The loss of agrobiodiversity presents several adverse effects such as loss of resilience in farming systems, productivity, income generation, food and livelihood security (Thrupp, 2000). Agricultural systems that provide rich food diversity leading to the improvement in nutritional and food security are also lost. The loss of indigenous crop varieties resulting from the decline in agrobiodiversity also affects the surrounding ecosystem and wild biodiversity.

The need to limit the occurrence and address the adverse effects of agrobiodiversity loss particularly genetic erosion has further been highlighted in the 2008 Ghana Country Report on the State of Plant Genetic Resources for Food and Agriculture. Bennet-Lartey and Oteng-Yeboah (2008) note that Ghana continues to experience widespread decline in genetic diversity due to factors such as land use change; marginalization of local crop varieties; and changing agricultural production systems. Though various interventions have been pursued in the past with the aim of addressing the effect of the declining agrobiodiversity in the country much still needs to be done particularly in terms of research effort. Past research studies such as Aboagye *et al.* (2007); Nyadanu and Lowor (2014); Nyadanu *et al*. (2014); Nyadanu and Aboagye (2014); Nyadanu *et al*. (2015); have all explored various aspects of NUCS in Ghana but there seems to be no comprehensive studies on the extent to which environmental and socio-economic as well

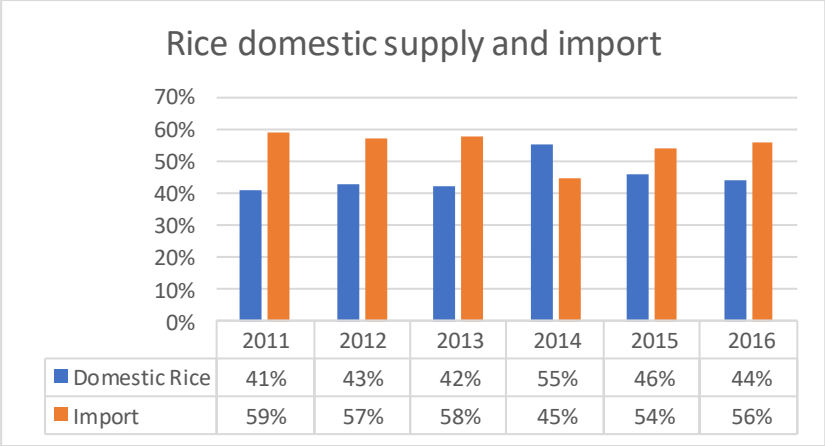
as factors from other critical drivers may be influencing the cultivation and use of NUCS particularly given their important role in agrobiodiversity and their potential to address the effects of climate change. A systematic investigation that will help generate an inventory of the forms and varieties of indegineous crops and their potential contribution to household food security in Central Ghana is therefore required.

The monocropping system which involves the cultivation of a single crop practiced by some farmers have also led to a gradual shift from the cultivation of a wide variety of crops to single or particular crops, a situation that has resulted in the decreased cultivation and marginalization of other important crop varieties. This cropping system engenders the use of agrochemical to fight pest (for example the fall army worms) often resulting in chemical abuse by some farmers. Ghana's current system of agricultural production also emphasizes the cultivation of key staples such as maize, rice, millet, sorghum, yam, cocoyam, plantain, groundnut, cowpea and soya bean (MoFA, 2016) to the marginalization of other crop varieties.

Agricultural markets over the years have also not favoured indigenous crop varieties due to the preference for high-yielding crop varieties, a situation that has resulted in the narrowing of the genetic base. This has implications for the availability of the wide variety of food crops required to ensure nutritional and food security. As noted by MoFA (2015) the effective commercialization or marketing of agricultural crops including NUCS is constrained by several factors.

Even though Ghana is said to be food secure in relation to most of its food staples, the country still relies on the import of some selected food commodities. Ghana over the years has imported various food commodities and key staple crops to supplement its domestic production in order to

address food insecurity. According to the Trade Statistics Department of the Ghana Statistical Service (2016), between 2007 and 2015, the total value of food imports of the eight major food commodities including rice, vegetables, and wheat increased by more than four-fold – from US$470 million in 2007 to nearly US$2.2 billion in 2014 and just under US$2 billion in 2015. Among the key staple crops that Ghana has imported over the years as a result of deficit in local production include: rice; maize tomatoes, onions and millet (MoFA, 2012; 2013; 2014; 2015; and 2016). In the year 2016, Ghana imported various quantities of rice and millet due to shortfalls in domestic production to meet local demands (MoFA, 2016). The report however notes that rice import particularly has consistently increased over the years, a situation that has implications for the economy.



	2011	2012	2013	2014	2015	2016
Domestic Rice	41%	43%	42%	55%	46%	44%
Import	59%	57%	58%	45%	54%	56%

Figure 1.1: Domestic supply and import of rice between 2011 to 2016 Source: GSS (2016)

Figure 1.1 shows a consistent increase and growth in import of rice over domestic supply from 2011 to 2016 with the exception of 2014 which recorded a decline of 45% in import compared to a 54% in domestic production. In order to reverse this current trend in key staples and food commodity imports, there is the need for the use of innovative ways to boost domestic food

production and also diversify to include the cultivation and use of other alternative food crops particularly NUCS in order to supplement local food production.

MoFA (2015) notes that about 5 percent of Ghana's population (1.4 million people) are food insecure. The Comprehensive Food Security and Vulnerability Analysis (CFSVA) study also revealed that food insecurity in Ghana is more prevalent in rural (19%) than in urban areas (4%) (WFP, 2012). Considering Ghana's growing population and level of food insecurity in rural areas, there is the need to broaden the range of food crops to include NUCS given their role in addressing food and nutritional security among rural households. This study particularly focuses on household food security in the middle belt of Ghana.

The absence of a specific and comprehensive policy direction for the promotion and use of NUCS as noted by Aboagye *et al.* (2007) is also a major challenge. There is therefore the need to generate evidence-based data on NUCS that will help form the basis for the consideration of such a policy in Ghana.

1.2 Aim and Objectives of the Study

1.2.1 Main Objective

The main objective of the study is to examine the factors underlying the decline in the cultivation and use of NUCS and their implications for household food security at the local level with the view to influencing policy decisions to promote NUCS, food and environmental security.

1.2.2 Specific Objectives

i. To inventorize and profile the varieties and uses of food crop varieties in Central Ghana;

ii. To determine the prevailing agricultural practices and their possible effects on NUCS cultivation;

iii. To determine the environmental and socio-economic factors that influence the cultivation and use of NUCS; and

iv. To highlight the experiences of rural households regarding food security and NUCS.

1.2.3 Research questions

- What are the varieties of food crops found in Central Ghana?
- What are the varieties of food crops that are currently marginalized or underutilized in the Upper Afram and Upper Dayi basins?
- What are some of the uses and benefits of NUCS in Central Ghana?
- What are the farming and agronomic practices in the study area?
- How are the prevailing agronomic or farming practices affecting NUCS cultivation?
- What has been the climatic (rainfall and temperature) trend; land use and land cover changes over time in the study area?
- How are these trends and changes affecting NUCS cultivation?
- How are market forces affecting cultivation, commercialization and utilization of NUCS?
- What are the current experiences of rural households on food security and NUCS in Central Ghana?

1.3 Significance of the Study

While available literature exists on the state of agrobiodiversity globally and the significance of NUCS and their potential contribution to food security among rural households in many

countries in Africa, there seems not to be sufficient evidence-based research that provides the theoretical knowledge on factors that influence NUCS cultivation and use in Ghana; and how such research output could be used to influence policy decisions in the agriculture sector. In spite of Africa's rich agrobiodiversity with its wide range of different plants species, crops, trees and animals, the potential of some indigenous crop varieties has not been adequately exploited.

In Ghana, agriculture plays a major role in the pursuit of the food security agenda, even though the security of food production continues to be threatened among others by factors such as unstable domestic agricultural production, increased food prices and inflation, low household incomes and persistent high level of unemployment (Nyanteng & Asuming-Brempong, 2003). Effectively addressing the many causes of food insecurity in the country will require increased research into the potential of lesser known and less utilized crops and plant species.

Exploring the potential of these crops through focussed research therefore remains a viable option for stakeholders in the agriculture sector given their tendency to enhance household food security. The research output of this study will help broaden the genetic base of food crops in the country. The study additionally will produce an inventory of the presently marginalized or neglected food crop varieties and also serve as a baseline data for further detailed research into the conservation of these threatened crops.

Traditional knowledge of plants or crops by local people play an important role in the identification of such often neglected natural resources for commercialization. However, much of the associated knowledge on NUCS held by the local people have also not been fully tapped through research. Many of these crop species are therefore being lost through both natural and anthropogenic activities.

This study more importantly will focus on providing a profile of NUCS particularly in the middle belt of the country and the factors influencing or militating against their potential use in Ghana's quest to address food insecurity among rural households. It is this evidence-based research effort that will provide policy makers the basis and an alternative to the current dilemma of Ghana's dependence on food import. The research will also be useful to MoFA particularly in the development of effective programmes that will equip farmers with the technical know-how needed for enhancing the cultivation and production of NUCS. This will result in farmers and agronomists developing positive attitudes towards NUCS.

A study by Aboagye *et al.* (2007) that analyzed existing national policies and legislation that enable or inhibit the wider use of underutilized plant species for food, agriculture and industry in Ghana, pointed to the absence of a single comprehensive policy document on NUCS. In order to stimulate discussions around these often neglected but important food crops among policy makers in Ghana there is the need for some deliberate scientific investigations to provide the relevant information for consideration. It is hoped that this research effort will initiate new thinking on the existing agriculture sector policy and cause policy makers to begin to commit to issues regarding NUCS and their contribution to food security in rural households in Ghana.

1.4 Scope

Out of the six agro-ecological zones in the country this study focused on the Forest Savannah Transition and the Semi- Deciduous Forest zones. The Forest Savanna Transition lies within the middle portion of Brong Ahafo region, the northern part of both Ashanti and Eastern regions and the western part of Volta region whilst the Semi-Deciduous forest zone lies across the northern part of Western region through southern Brong Ahafo, Ashanti and Eastern regions further

extending to eastern part of Volta region and most parts of the Central region. These zones are major food producing areas of the country where crop diversity is high and serve as food hubs for most of the urban areas in southern sector. The study sites where the research was undertaken were selected within the Upper Afram and Upper Dayi River basins. The study communities within the Upper Afram include: Dromankoman, Nokwareasa, and Drobong and those in the Upper Dayi basin include Likpe Kukurantumi, Lolobi Kumasi, and Santrokofie Benua.

CHAPTER TWO

LITERATURE REVIEW, CONCEPTUAL AND THEORETICAL FRAMEWORK AND PROPOSITIONS

2.0 Introduction

This chapter presents the relevant background literature, conceptual and theoretical underpinnings; definitions and propositions of the study. It starts by examining the relationship between human livelihood, agriculture, agrobiodiversity and NUCS. It further provides detailed review of NUCS and the factors affecting their use and cultivation. Environmental factors such as land use and land cover changes and climate change; as well as other critical drivers including agronomic practices; and market forces influencing NUCS cultivation and use have also been reviewed. The concept of food security and the potential contribution of NUCS in addressing household food security have also been discussed. The chapter additionally presents the specific gaps that are to be addressed by this study.

2.1 Human livelihood and agricultural biodiversity

Agriculture constitutes the main source of livelihood for 2.5 billion people globally. It is estimated that a sixty percent increase in global food production will be required to feed over 9.5 billion people by 2050 (FAO, 2016). Agriculture is therefore essential to human sustenance and livelihood, yet biological diversity that underpins sustainability of agricultural production and livelihood of most people are under threat (Sunderland, 2011). The importance of biodiversity to humans is seen through its provision of ecosystem services such as carbon sequestration, watershed protection, and nutrient cycling (Jarvis *et al*., 2007); and other essential products such as food, fuel, medicine, and fibre among others for human sustenance (Fanzo *et al.* 2013).

Biodiversity comprises three main levels; ecosystem; species found in the ecosystem; and genetic diversity that occur within the species in the ecosystem (Bioversity International, 2017). Biological diversity in agricultural systems also referred to as agrobiodiversity is an important component of biodiversity.

The Convention on Biological Diversity (CBD), defines, agro-biodiversity as a broad term that includes all the components of biodiversity that have relevance to agriculture and food, and all the components of biodiversity that constitute the agro-ecosystems. Bioversity International (2017) also describes it as the biological variety exhibited among crops, animals and other organisms used for food and agriculture, as well as the web of relationships that bind these forms of life at ecosystem, species, and genetic levels. It includes not only crops and livestock directly relevant to agriculture, but also many other organisms that have indirect effects on agriculture, such as soil fauna, weeds, pollinators, pests and predators. The development and evolution of agrobiodiversity has been attributed largely to the diverse management practices of farmers, forest managers and other users of natural resources (Lopez-Noriega *et al.*, 2017). Agrobiodiversity comprises several components of which NUCS is an integral part. It is the basis of global food security and therefore its loss has adverse impact on sustainable agriculture (Padulosi *et al.*, 2013; FAO, 2010; Biodiversity International, 2017).

2.1.1 Neglected and Underutilized Crop Species (NUCS)

The term "Neglected and Underutilized Crop Species" (NUCS) has been conceptualized differently by various researchers and experts. Establishing a universal definition for NUCS has therefore been difficult. This, according to Azam-Ali (2010), could be explained by the different factors influencing the less use of such crops and species. As a result, there seems to be no

consensus definition on NUCS. Numerous terms including “minor crops,” “neglected species” or “orphan crops,” “underexploited” and “underdeveloped” species have therefore been employed to characterize these crops. For the purpose of this study, neglected and underutilised crop species (NUCS) will be used.

In spite of the lack of uniformity in defining NUCS, some attempts have been made to define them. According to Azam-Ali (2010), NUCS are crops that have hitherto not been categorised as major crops, have not had much research done on them, are not being used in a major way at present and are largely restricted to smallholder farming areas. Aboagye *et al.* (2010) also conceptualised NUCS as a class of crops that have a low consumption importance, use and production and as such, much is not made of them in order to add to the national economy. Padulosi *et al.* (2013) further expanded on Azam-Ali (2010) argument by defining NUCS as any agricultural or non-timber forest species, collected, managed, or cultivated and most importantly, is locally abundant.

Ebert (2014) also in expanding on Azam-Ali (2010) definition asserted that NUCS are crops and species of which little attention is paid or which are entirely ignored by agricultural researchers, plant breeders and policymakers. Ebert (2014) however failed to indicate the specific aspect of NUCS in which little attention is paid to by researchers. However, it is clear from both definitions that one of the major characteristics of NUCS is the apparent lack of interest by public or private research institutions on such crops.

Unlike Azam-Ali (2010) and Ebert (2014), Arora (2014) defined NUCS from a wider community perspective by referring to them as crops and species that many communities traditionally use for food, fibre, animal fodder, oil or for medicine, but that have further

undeveloped potential uses. As stated by Mabhaudhi *et al.* (2017), most NUCS possess attributes that make them ideal for production under low input agricultural systems and in marginal production areas; yet, many farmers have not maximized this opportunity.

In this study, Azam-Ali's (2010) conceptual definition of NUCS is adopted. According to Azam-Ali (2010), NUCS are crops that have hitherto not been categorised as major crops, have not had much research done on them, are not being used in a major way at present and are largely restricted to smallholder farming areas.

2.1.2 Geographical distribution and diversity of NUCS

Globally, there are over 30,000 plant species edible to human kind and about 7000 grown or collected for food. At present, only 30 staple crops feed the world (FAO, 2017). Neglected and Underutilized Crop species occur in both tropical and temperate regions including Sub-Saharan Africa; Latin America; and South and East Asia (Padulosi *et al.,* 2013). While the use of NUCS is widespread and can be found in many countries, their importance is not clearly evident in many European countries. In Asia and the Pacific particularly in countries such as Malaysia, Nepal, India and the Philippines, NUCS have been reported to serve as source of food and medicine. In Sub Saharan Africa, the use of NUCS is common in countries such as Malawi, Nigeria, Cote d' Ivoire, Uganda, and Zimbabwe. (Padulosi *et al.,* 2013; FAO 2010).

Examples of NUCS found in Sub Saharan Africa include *Amaranthus sp.* (Laker, 2007); wild mustard (*Brassica* spp.) and other wild edible leafy vegetables (Modi *et al.,* 2006). Others include taro (*Colocasia esculenta*); sweet potatoes (*Ipomoea batata*); bambara groundnut (*Vigna subterranea*) and wild melon (*Cucurbita* spp). In Nigeria, NUCS such as fonio (*Digitaria exilis,*

D. iburua), Ethiopian tef (*Eragrotis tef*), lima beans (*Phaseolus lunatus*), pigeon peas (*Cajanus cajan*) and *Vigna subterranea*, *Crotalaria spp*. and *Solanum nigrum* are very common. Zimbabwe reports significant use of finger and pearl millets, while in Malawi, NUCS are prevalent, particularly with regard to Bambara groundnut (*Vigna subterranea*), sorghum, finger millets and pearl millets (Padulosi *et al.,* 2013).

Dansi *et al.* (2012) examined the diversity of the neglected and underutilized crop species in Benin using a survey of 50 villages. The findings identified 41 NUCS among which 19 were identified as of priority base on ten (10) criteria among which included their extent and degree of consumption. The study concluded that Benin has a great diversity of neglected and under-utilized crop species. Unfortunately, they have never been the priority of the national agricultural research system mainly because of lack of political will and financial supports.

In Ghana Aboagye *et al.* (2010) note that there are several wild species which can be potentially useful in plant breeding programmes, even though an exhaustive list of these species does not currently exist in Ghana. These include wild cowpea species such as *Vigna reticulate,* wild yam (*Dioscorea* sp), wild oil palm, and most medicinal plants such as mahogany (*Khaya senegalensis*) and *Rauwolfia vomitoria*. Whilst some of these wild species have been collected, Aboagye *et al.* (2010) noted that most have not; yet Ghana is known to be the centre of origin or centre of diversity of landraces of several crops such as yams, which are generally used for food in various regions of the country. Aboagye *et al.* (2010) categorised NUCS in Ghana as vegetables, leafy vegetables, edible wild fruits, cereals, legumes and roots and tuber crops (Table 2.1).

Table 2.1: Some varieties of NUCS in Ghana

Vegetables	**Indigenous Leafy vegetables**	**Edible Wild fruits**
Tricianthes cucumeria, Colocynthis edulis, Sechium edulis, Telfaria occidentalis, Lagenaria cicerasiaa, Cucumeropsis edulis, Solanum aethiopicum Solanum macrocarpum, Solanum torvum, Solanum pinpinellifolium, Birds eye chillie	*Celocia argenta, Cochorus olitorious, Cleome gynandra, Talinum triangulare, Vernonia hybridus, Amaranthus cruentus, Basella alba, Amaranthus hybridus, Moringa oleifera, Vernonia amygdalina, Wild lettuce, Hibiscus sabdariffa*	*Morinda morindiodes,* *Salacasia pyriformis,* *Dacryodes klaineana,* *Diospyros vignei,* *Chrysophyllum albidum, Heisteria parvifolia, Irvingia gabonensi, Drypetes chevalieri, diospyros soubreana, Solacia cornifolia, Cola milenii, Atrocarpus utilis, Anona muricata, Velvet tamarind*
Cereals	**Legumes**	**Root and tuber crops**
Digitaria exilis, Eleusine corocana, Oryza glaberrima,	*Kerstingiella geocarpa,* *Sphenostylis sternocarpa* *Cajanus cajan, Vigna subterranea, Mucuna pruriens* var. *utilis* (W), *Canavalia ensiformis,* *Canavalia gladiata, Phaseolus lunatus*	*Dioscorea cayenensis* *Dioscorea bulbifera,* *Dioscorea dumetorom* *Dioscorea praehensilis* *Solenostemon rotundifolius* *Colocasia esculenta*

Source: Adopted from Aboagye *et al.* (2010)

2.1.3 Uses and benefits of NUCS

Neglected and Underutilized Crops are known to provide several benefits. Most NUCS possess high nutritional content such as protein, vitamin B_2, and vitamin C, and are used as alternatives

to conventional vegetables in human diet (Mengistu and Hager, 2008). These crops have historically served as dietary support to rural communities (Chivenge *et al*. 2015). Padulosi *et al* (2013) further adds that NUCS provide essential micronutrients and flavouring in local cuisines.

Many NUCS are also known to play a key role in maintaining cultural diversity as these indigenous crops and plant species constitute an intimate part of traditions and local cultures (IPGRI, 2002). Indigenous communities therefore attach much significance to the use of NUCS and their traditional food system due to their contribution to the physical health and the maintenance of cultures (Padulosi *et al*., 2013).

Some NUCS are used as nutraceutical due to their important medicinal properties. The pharmacological properties make them usable in the treatment of several human diseases including hypertension, breast cancer, burns, inflammations, injuries, infections, sexually transmitted diseases and liver complaints (Dansi *et al*., 2012). However, Cunningham (2001) argues that the medicinal nature of most plants known through traditional knowledge is often rapidly lost once indigenous people become integrated into modern, materialistic society. Some NUCS therefore have many important medicinal properties and can be used as nutraceutical. For example, *Crassocephalum sp*. has antibiotic, anthelminthic, anti-inflammatory, anti-diabetic, anti-malaria and blood regulation properties in addition to the treatment of indigestion, liver complaints, colds, intestinal worms, and hepatic insufficiency (Dansi *et al*., 2012). The leaf of *Cleome gynandra* which is consumed as leafy vegetable has anti-inflammatory and lysosomal stability actions (Narendhirakannanm *et al.,* 2007). Obi (2011) has also reported that leaves extract of *Launaea taraxacifolia* used by the Beninese has virucidal potential. Gill *et al.,* (2010) also reported that *Citrullus lanatus* has good antioxidant, anti-inflammatory, and analgesic

potential and may be used as a future food medicine. Tubers of Tigernut (*Cyperus esculentus*) are said to be aphrodisiac, carminative, diuretic, and have potent antioxidant and anti-inflammatory properties (Adejuyitan, 2011).

Apart from the nutritional and medicinal properties, NUCS also possess other important characteristics that make them relevant to the environment. The International Plant Genetic Resource Institute (IPGRI, 2002) notes that environmental issues such as land use changes; the impact of climate change; and the degradation of land and water resources among others have led to a growing interest in crops such as NUCS. Their ability to flourish under unfavourable conditions makes them valuable in climate change mitigation and sustainable food production (Bala Ravi *et al.*, 2006). They are relatively more resistant to biotic challenges and able to thrive in diverse ecological niches and under harsh environments such as poor soils and drought (Shackleton *et al*., 2009).

NUCS historically have played a role in the provision of income generating opportunities and household food security among indigenous communities and small holder farmers (Mabhaudhi *et al.*, 2011). Considering the importance of NUCS, there is the need for increased utilisation and awareness about the medicinal and nutritional benefits associated with their uses.

2.2 Farming systems, agronomic practices and NUCS

Humans, since prehistoric times, have depended on activities such as hunting, fishing and food gathering for their sustenance and livelihood. Chandrasekaran *et al.* (2010) however notes that this method of gathering food for human sustenance evolved and farmers began to rely on the cultivation of wild plants and domestication of wild animals. This then culminated into the

deliberate cultivation of land with the view to producing crops and livestock for food and other purposes. Since then the approach to farming has evolved leading to the development of different farming systems such as shifting cultivation, subsistence farming, mixed farming, crop rotation (Chandrasekaran *et al.,* 2010).

In Sub Saharan Africa different methods of farming are practiced (Callo-Concha *et al.* (2012). Among these include the Pastoral, Highland perennial, Irrigated, Forest based, Tree crop and Root crop systems. According to Gyasi and Uitto (1997) the system of farming that characterized farming for many years in West Africa was mainly based on fallow migratory systems also known as shifting cultivation. Since then other systems of farming have evolved. In Ghana, the main system of farming employed by most traditional small holder farmers is the intercropping system even though monoculture is also practiced among farmers engaged in large scale farming. Farming in Ghana is predominantly on a subsistence basis even though large commercial farms and plantations also exist (MoFA, 2007).

A vital aspect of farming systems that relates to the success of food crop cultivation and production is the application of good agronomic practices. The practices associated with the production and improvement of crops including the prudent use of water, efficient soil management, workforce among others is known as agronomy (Chandrasekaran *et al.,* 2010). It also includes the deliberate selection of crop varieties adaptable to specific agro climate, soil fertility, method of cultivation and season. Employing good agronomic practices can help ensure good agricultural yields.

In Ghana practices such as bush burning, uncontrolled use of agro chemicals, inappropriate tillage and water management practices are among some of the activities that constrain

agricultural production (MoFA, 2007). SPRING (2017) highlights some of the agronomic practices employed in the production of legume crops such as groundnut in the Northern region. Among these include seed selection, plant spacing, weed control and fertilizer application.

Traditional farmers over the years have cultivated and relied on a wide range of indigenous crop varieties and livestock breeds for their livelihood (Stefanie & Amend, 2008). However, this has changed due to the emphasizes on the cultivation of high-yielding crop species (Lopez-Noriega *et al.*, 2017), a situation that has resulted in the marginalization of other indigenous crop varieties including NUCS. In India NUCS are cultivated mainly as mixed or inter crop along with fodder yielding cereals such as sorghum, grain legumes and maize. However, the reliance on traditional and inefficient agronomic practices and the lack of appropriate technology is affecting the competitiveness of NUCS (Bala Ravi *et al.,* 2010) even though NUCS possess inherent agronomic advantage such as adaptability to low input agriculture and marginal lands (Padulosi *et al.*, 2002). Even though water availability remains a major constraint to crop production in Sub Saharan Africa, some indigenous crops such as NUCS are known to thrive inspite of water scarce conditions. Comprehensive studies on the agronomy, water requirements, nutrition and genetic potential of NUCS are however lacking (Chivenge *et al.,* 2015). A study by Nyadanu *et al.* (2015) on the relationship between cultural practices in traditional farming systems and the safety of NUCS conserved on farm in Ghana, highlighted mass use of systemic weedicides by farmers and the lack of knowledge of conservation of seeds and tubers of NUCS as the key factors responsible for genetic erosion of NUCS.

2.3 Factors that influence the cultivation and use of NUCS

The cultivation, utilization and commercialisation of these indigenous crops and plant species however are constrained by several factors. Environmental concerns such as land use changes and the impact of climate change have led to a growing interest in plant genetic resources and indigenous crops such as NUCS (IPGR, 2002). This section therefore examines the influence of land use and cover changes and climate change on the cultivation and use of NUCS.

2.3.1 Land use and land cover changes

Lambin *et al.* (2006) defines land use as 'the purpose for which humans exploit land cover". It also refers to human activities undertaken in a particular land cover type with the view to changing or maintaining land cover (FAO, 1998). Humans since prehistoric times have used land for various purposes including agriculture, water and ecotourism, reforestation, transport, settlement (Ogechi & Hunja, 2014). These activities over time have resulted in changes and adverse impact on the land resource.

Land use change therefore refers to change or shift in the way humans use or interact with land resource or natural environment (Jose & Padmanabhan, 2015). Land cover on the other hand refers to the bio-physical cover over land surface including vegetation, water, bare soil as well as artificial structures (Erle & Pontius, 2007). In other words, land cover can be observed directly in the field whilst land use constitutes human activities such as agriculture and building construction that modify land surfaces.

In highlighting the relationship between land use and land cover changes Lambin *et al.* (1999) note that land use changes determine the extent or nature of land cover changes. Changes in land

use and land cover are a source of growing concern that can be traced to several decades of human interaction with the environment. Some of the impacts of land use changes include biodiversity loss, erosion, flood and climate change (Bicík *et al.,* 2015).

Mussa *et al.* (2017) in a study on land use land cover changes and the perceptions of local communities towards land cover changes in the Raitu district of Bale, Southeast Ethiopia, showed that cultivated land, settlement, bush land and bare land expanded by 13.81, 14.30, 12.62 and 22.3% respectively, between 1986 and 2016, whilst wood land, grassland and shrubby grassland declined by 33.82, 24.4 and 3.36% respectively. According to the study implementation of inappropriate government policy and development interventions, climatic, demographic, anthropogenic were identified as the key drivers of the observed changes in land use and land cover in the area. The study further noted some of the environmental and livelihood implications of the changes. Among these include soil degradation, biodiversity loss, bush encroachment, livestock loss, and rangeland degradation.

In another study that investigated the implications of land use and land cover changes on food production in Keumbu Region Kisii County, Kenya**,** Ogechil and Hunja (2014) observed that urbanization, population increase and agricultural land fragmentation were responsible for the decrease in food production and agricultural land. This in turn affected rural household food security in the area.

Studies on the land cover change patterns in the Volta gorge area of the Volta basin of Ghana between 1975 and 2007 by Ampofo *et al.* (2015) also revealed significant changes in the landscape with a pattern of conversion of both closed and open forest as well as woodland into pasture fallow lands, cropland, and bare areas consisting settlements, roads and exposed soil

surfaces. The study further showed that the increased agricultural activity was responsible for the significant land cover change occurring in the Volta Gorge area.

2.3.2 Climate variability

Climate change continues to be a major global challenge in our world today. Among the regions of the world that are most susceptible to the adverse effects of climate change is Sub Saharan Africa (IPCC 2014; 2007). Climate change causes erratic rainfall patterns and decreasing crop yields, contributing to increased hunger (Obayelu *et al.*, 2014). According to the FAO (2008), agricultural production in low-income developing countries, particularly Africa is adversely affected by climate change. This is further explained by the assertion of the FAO (2014) that the effect of climate change is expected to increase the frequency and intensity of weather extremes in these areas. This is largely to affect the quality and quantity of food and crops produced, since the agro–ecology of most developing countries; particularly in Africa is dominated by semi–arid to arid environments. The potential impact of climate change on the diverse range of underutilized crop species has not so far been assessed (Padulosi *et al.*, 2011). Yet, Sohl (2016) indicated that alongside their commercial potential, many of the underutilised crops also provide important environmental services, as they are adapted to marginal soil and harsh climatic conditions.

In Ghana, the unstable climatic conditions are contributing to the loss of species and genes. According to Aboagye *et al.* (2010), there is a downward drift of the savanna thus, affecting the survival of certain crops in the transitional zones. Sagoe (2006) also notes the adverse effects of climate change on crop production during the drought period in 1990 in Ghana. The drought period however elapsed followed by a period of increased rainfall from 1991-1992. Agricultural

food production (including the cultivation of NUCS) is therefore susceptible to climate variability. Despite a growing awareness of the potential of underutilized crop species for future climate change adaptation and human wellbeing, they continue to be threatened primarily from habitat loss, fragmentation, and degradation. Underutilized crops and plant species are therefore under-conserved.

2.4 Market forces and NUCS

Kotler and Keller (2012) describes the term marketing as identifying and meeting human and social needs. However, for the purpose of this study market or marketing is used in relation to the sale, distribution and use of agricultural products. Market is therefore used in this context to refer to the place of interaction between the two major forces of demand and supply of agricultural goods. Markets historically have had adverse effect on agricultural biodiversity. This is due to the preference of agricultural markets for crop varieties with high yields (Lenzen *et al*., 2012; Rao *et al*., 2005; Gruère *et al*., 2006; Lamers *et al*., 2016). This situation subsequently has led to the narrowing of the genetic base. The Food and Agriculture Organization also highlights factors such as lack of competitiveness of NUCS with other crops as well as incentives for farmers to continue to maintain NUCS in their fields; absence of market infrastructure and market niches for NUCS; and low commercial value of NUCS as some of the key constraints to the effective use and commercialization of NUCS (FAO, 2010). Ouma *et al.* (2010) also attributes the inability of farmers to participate agricultural markets to factors such as high transaction cost and poor marketing infrastructure. In Ghana, access to agricultural markets are affected by factors such as weak commodity value chains, lack of marketing skills, and poor infrastructure (MoFA, 2007).

In a review that examined the economic factors that causes crops to be underutilized, Gruère *et al.* (2006) identified factors such as presence of market imperfections and market failures; the presence or absence of an output market as well as the observed and potential economic value of the species. The review further notes that factors such as increased efficiency of supply and marketing channels; demand expansion; and supply control mechanisms are critical for effective commercialization of NUCS. Gruère *et al.* (2006) further argues that crop species are underutilized as a result of market imperfections, that is demand and supply. The lack of product knowledge and inadequate economic information on NUCS result in lower demand.

2.5 Agriculture and food policy and NUCS

Haddad and Demsky (1995) define policy as an explicit or implicit single decision or group of decisions which set out directives for guiding future decisions, initiate or retard action, or guide implementation of previous decisions. A policy therefore sets out clear directions and strategies to guide decision making. Even though the existence of a policy does not guarantee success it is key in achieving a desired goal or intent. In a study that examined the agriculture sector policies of countries such as Ghana, Jordan, Nepal, Papua New Guinea, Peru, Uzbekistan, Vietnam and Zambia, it was observed that the sector policies did not focus specifically on underutlised crops or plant species (Chishakwe, 2008). In Jordan for example the National Strategy for Agricultural Development emphasizes on the protection of agro-biodiversity including plants and animals but does not make specific reference to underutilized species. While the National Agriculture Policy of Nepal promotes and ensures the development of commercial crops on a large scale, it also creates a situation that decreases the use of underutilized crops in localities where they are found.

The study further noted that even though the food security policies of these countries ensured that people obtained adequate food, through increased food production, some of the policies also constrain the production of underutilized species. While the lack of specific policy provision remains a challenge, some countries are pursuing research with particular focus on underutilized plant species (Chishakwe, 2008). In Ghana, the Food and Agriculture Sector Development Policy (FASDEP II) is the key policy instrument that guides agricultural production and food security issues. The policy among other things emphasizes and focuses on selected priority crops to the neglect of underutilized crop due to their economic importance. Aboagye *et al.* (2007) in a similar study on national policies and legislations that influenced the use of underutilized plant species also revealed that there is currently no single comprehensive policy on underutilized crops in Ghana even though there is some kind of consensus on their potential impact on food security.

2.6 NUCS and household food security

2.6.1 Household food security

Food security is increasingly recognised as an important element of sustainable development. In this respect, it is one of the seven pillars of the UN development programme's original concept of human security. Establishing a universal definition of food security has been challenging, particularly due to the complex multifaceted issues concerning not just agriculture, technology and trade, but also multiple political and social considerations (UNESCAP, 2009). According to Lemba (2009), food security is when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

A review of the global prevalence statistics is relevant in order to appreciate the magnitude of the problem of food insecurity and the need to explore alternatives like the promotion of NUCS. Although food security affects almost everyone on the globe, Sub-Saharan Africa has the widespread chronic food insecurity. Out of the 39 countries in the world which were experiencing serious food emergencies and required external assistance for dealing with critical food insecurity, twenty-five (25) were in Africa, eleven (11) in Asia and Near East, two (2) in Latin America and one in Europe (Watuleke, 2014). In 2016, the number of undernourished people in the world increased to an estimated 815 million, up from 777 million in 2015, but still down from about 900 million in the year 2000. Similarly, while the prevalence of undernourishment is projected to have increased to an estimated 11 percent in 2016, this is still well below the level of a decade ago. The food security situation has visibly worsened in parts of sub-Saharan Africa and South-Eastern and Western Asia (FAO, 2017).

In Ghana, five percent of the population (1.2 million people) is food insecure (MoFA, 2015). Despite the fact that the agriculture sector is a significant contributor to the growth of the economy and employing majority of the labour force, Ghana is yet to achieve self-sufficiency in the production of food. MoFA (2015) further shows that Ghana has deficits in the production of cereals, meat and fish, but only self-sufficient in the production of root and tubers. This self-sufficiency however is chequered with pockets of scarcity, sufficiency and glut depending on the season.

Wangthamrong (2010) argues that the concept of food secuirty can be viewed in two main ways, that is, at the macro or the micro level. At the macro level, food security means that enough food has to be available to cover the whole population's nutritional requirements, while at the micro

level, for households and individuals. For the purpose of this study, food security is viewed from a micro-level, thus household food security. The Food and Agriculture Organization describes household food security as the capability or capacity of a household to obtain adequate food that meets the dietary needs of all members of the household through its own production or purchases. By implication households can be termed food insecure when the available food is insufficient to feed members of the household in a day in a given period.

Zakari *et al.* (2014) in a study that examined the factors that influenced house food security in West Africa specifically in Southern Niger found that gender of the head of household, labour supply; flooding; access to market; diseases and pests; distance away from the main road, poverty and food aid all significantly influence food security status of the households. The study also found that female headed households were more susceptible to food insecurity than male headed households.

The 2009 Comprehensive Food Security & Vulnerability Analysis (CFSVA) report also revealed that food insecurity in Ghana is a challenge particularly in the areas most prone to adverse weather conditions, such as floods and droughts, which are also the poorest regions of the country (WFP, 2009). According to the Comprehensive Food Security and Vulnerability Analysis (CFSVA) food insecurity in Ghana is more prevalent in rural (19%) than in urban areas (4%) (WFP, 2012). The report further identified four major causes of food insecurity in Ghana namely poverty; seasonal challenges; high food prices and agricultural limitations. Small land size and lack of crop diversity were also highlighted as contributing to food insecurity particularly among households in three Northern regions.

In a study that examined the determinants of household food security and the effect of climate variability on agricultural production in the Upper East Region of Ghana, Abubakari and Abubakari (2015) randomly sampled households in seven communities with the view to analyzing the determinants of household food security among farmers in the Talensi Nabdam District. Results from the study showed that 43% of the household were food secured and 57% of the household were food insecure. Analysis of the determinants of household food security showed that farmer-based organization, household size; extension contact and labour had significant impact on household food security in the study area.

2.6.2 Household food security and NUCS

Neglected and underutilized crops are known to play a key role in the improvement of the livelihood and the attainment of food security among local people in rural areas (Nyadanu *et al.,* 2014; Magbagbeola *et al.,* 2010). Bhattacharjee (2009) also notes that underutilized crops have the potential of improving incomes, nutrition and food security in remote areas of developing countries. In a review that explored the potential of Bambara groundnut, an underutilized plant species, towards food security in Africa, Muhammad (2014) highlighted the high nutritional composition of the plant compared to other many leguminous crops. The legume crop which is native to Africa contained high levels of protein and minerals and therefore could play a significant role in achieving food and nutritional security.

Sprent *et al.* (2009) in a similar review on the potential of African legumes including *Acacia senegal,* cowpea, Gum arabic, among others indicated that a focus on such crops could potentially contribute to diversity of agricultural food crops thereby decreasing the reliance on a few crops and plant species. This potentially could help address food insecurity.

Many underutilized plant species are nutritionally rich and adapted to low input agriculture (Padulosi *et al.* 2013), thus they complement significantly the diet based on few staple crops by providing important vitamins and minerals. This according to Anzu (2016), NUCS provide a unique opportunity to combat food and nutritional insecurity.

Historically, NUCS have played an important role in ensuring community and household food and nutrition security. This according to Mabhaudhi *et al*. (2011) is achieved through the provision of healthy alternatives when the main crop failed or during period's in-between subsequent harvests. Additionally, NUCS provide flavouring in local cuisine, strengthen local cooking traditions and provide income opportunities for both the rural and urban poor (Azam-Ali, 2010). Anzu (2016) argues that underutilised species have the potential in sustaining livelihoods, possessing medicinal and economic values, and help to reduce food insecurity. Mayes *et al.* (2012) also note that NUCS can improve food security by being a part of a focused effort to help the poor in rural households and also in terms of income generation.

2.7 Definition of key terms used in the study

Agricultural biodiversity (Agrobiodiversity): Bioversity International (2017) defines agrobiodiversity as the biological variety exhibited among crops, animals and other organisms used for food and agriculture, as well as the web of relationships that bind these forms of life at ecosystem, species, and genetic levels.

Agronomy: This refers to the practices associated with the production and improvement of crops including the prudent use of water, efficient soil management, workforce among others (Chandrasekaran *et al.,* 2010).

Climate change: refers to the long-term changes in average weather conditions. Climate change causes erratic rainfall patterns and decreasing crop yields, contributing to increased hunger (Obayelu *et al.,* 2014).

Food security: According to Lemba (2009), food security is when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

Household food security: The Food and Agriculture Organization defines household food security as the capability or capacity of a household to obtain adequate food that meets the dietary needs of all members of the household through its own production or purchases.

Land Use: refers to the human activities undertaken in a particular land cover type with the view to changing or maintaining the land cover (FAO, 1998)

Land cover: refers to the bio-physical cover over land surface including vegetation, water, bare soil as well as artificial structures (Erle & Pontius, 2007).

Market forces: Market as used in this context refers to the place of interaction between the two major market forces of demand and supply of agricultural goods.

Neglected and Underutilised Crop Species (NUCS): are crops that have hitherto not been categorised as major crops, have not had much research done on them, are not being used in a major way at present and are largely restricted to smallholder farming areas (Azam-Ali, 2010).

Policy: Haddad and Demsky (1995) define policy as an explicit or implicit single decision or group of decisions which may set out directives for guiding future decisions, initiate or retard action, or guide implementation of previous decisions.

2.8 Conceptual and Theoretical Framework

The study employed both conceptual and theoretical frameworks to help address the research objectives of the study.

2.8.1 Conceptual framework

This section provides a conceptual framework (Figure 2.1), that draws from various concepts with the view to examining the critical factors underlying the underutilization of crop and plant species and the implications for household food security at local level. This section also analyses the broad concepts deemed key and important to the study and further explains the linkages between the various concepts.

The study acknowledges the important relationship between agricultural biodiversity and human livelihood; and the potential adverse impact of the decline or loss of this diversity on food security. According to Bioversity International (2017) agrobiodiversity involves the intentional use of the diversity among plants, animals, soil organisms among others to address food insecurity**.** Farmers traditionally have depended on and cultivated a wide range of indigenous crop varieties and livestock breeds for food (Stefanie & Amend, 2008). Humans have therefore relied on the diversity of plants and animals for their sustenance and livelihood. Agrobiodiversity provides several benefits and services. However, the current decline in agricultural biodiversity (crops and plants) globally is a source of growing concern **[A].**

In Ghana, the decline in genetic diversity is widespread, a situation that has been attributed to factors such as the changing agricultural production systems among others (Bennet-Lartey & Oteng-Yeboah, 2008). Lopez-Noriega *et al*. (2017) note that modern system of agriculture now

favours the cultivation of high-input and high-yielding crop species, often leading to the marginalization of other crop and plant varieties. The system of agricultural crop production that currently pertains in Ghana also emphasizes the cultivation of key staples such as maize, rice, millet, sorghum, yam, cocoyam, plantain, groundnut, cowpea and soya bean (MoFA, 2016) **[B].**

This change in agricultural system has resulted in the marginalization and underutilization of some local crop varieties also referred to as NUCS **[C].** While agriculture continues to contribute to Ghana's development particularly in addressing food security, local food production has historically not fully addressed the shortfalls in demands. As a result, Ghana still relies on the import of some selected food commodities such as rice; maize tomatoes, onions and millet to supplement domestic production (MoFA, 2012; 2013; 2014; 2015 and 2016).

Diversifying food crop production to include the indigenous crop varieties that have often been neglected and underutilized is critical **[D].** Diversifying food production and consumption habits to include NUCS can influence and contribute to improved nutrition and household food security (Jaenicke & Höschle-Zeledon, 2006). Broadening the food basket through the cultivation and integration of other neglected and less utilized local crop varieties with the current key staple crops can help address Ghana's food inadaequacy challenges thereby contributing to food security particularly among rural households.

Neglected and underutilized crops possess several useful traits that make them important to the environment and for food security. Among some of the benefits that NUCS provide include: nutritional (Mengistu & Hager, 2008; Chivenge *et al.*, 2015; Padulosi *et al*., 2013); medicinal (Dansi *et al*., 2012; Gill *et al*., 2010; Obi, 2011); economic (Mabhaudhi *et al.*, 2011); and environmental (Bala Ravi *et al.,* 2006; Padulosi *et al.,* 2013) **[E**

CONCEPTUAL FRAMEWORK

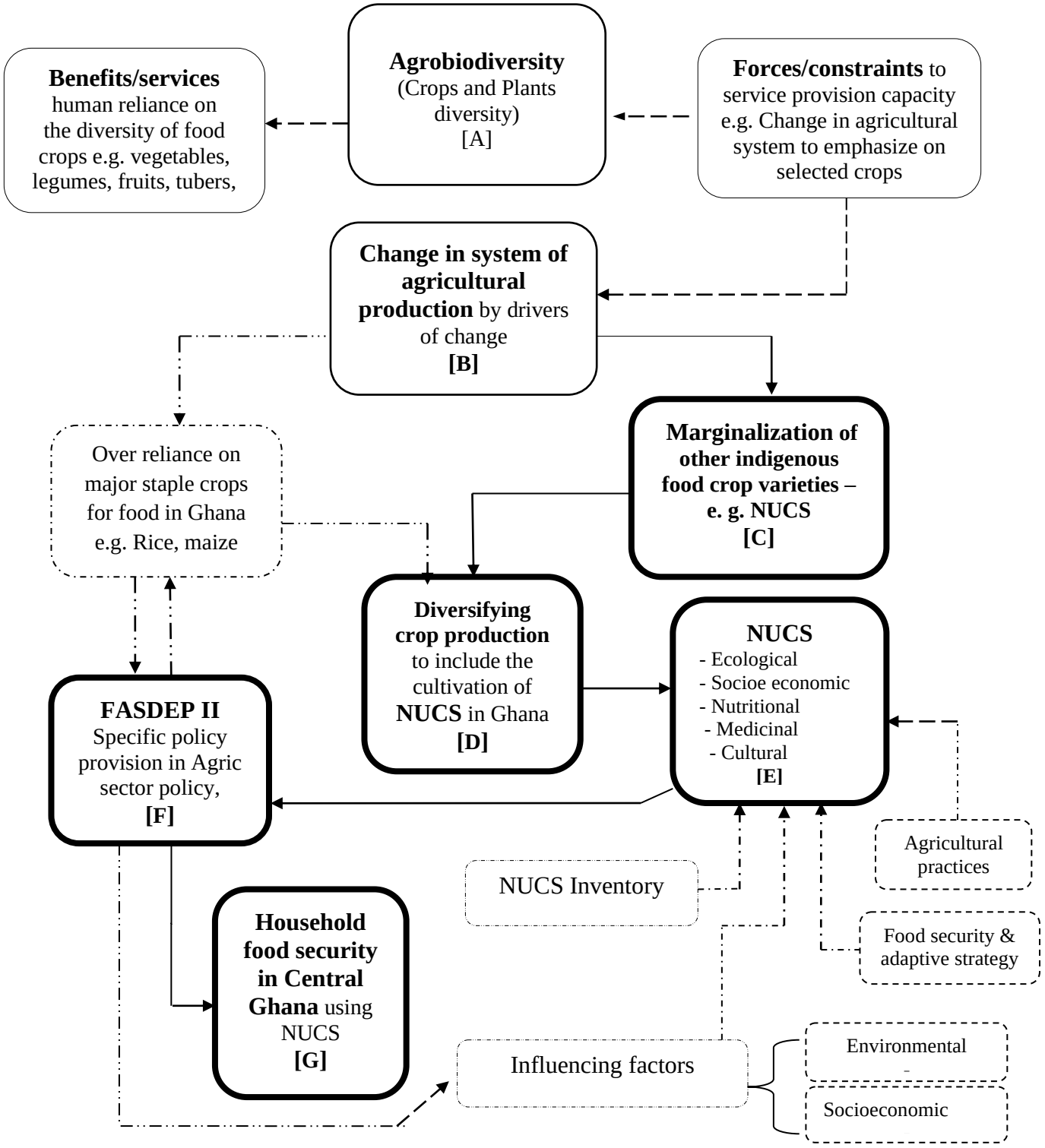


Figure 2.1: Conceptual framework of the study *Source: Author*

Inspite of these important benefits, NUCS cultivation and use are constrained or affected by several factors. Among these include lack of appropriate legal framework; climate change impact; abuse of pesticides and other agrochemical; impact of market forces; loss of traditional knowledge of indigenous crops; and land use change (FAO, 2010). In Ghana the effect of these factors has not been adequately investigated hence the need to examine how factors such as land use and cover changes; climate variability; agronomic practices and market forces are affecting the cultivation and promotion of NUCS in the country.

In order to address the challenge possessed by the current market preference for high yielding crops in Ghana and the subsequent marginalization of NUCS which are known to contribute to food security among rural households; there is the need for the creation of an enabling environment through the institution of the right legal framework or specific policy **[F]** that will ensure that effective strategies and plans are developed and pursued to promote NUCS. Haddad and Demsky (1995) define policy as "an explicit or implicit single decision or group of decisions which may set out directives for guiding future decisions, initiate or retard action, or guide implementation of previous decisions".

Ghana currently has an agriculture sector policy, FASDEP II that does not adequately emphasize the cultivation and promotion of NUCS (MoFA (2007). A specific and comprehensive policy provision for NUCS will be required to encourage and gradually introduce some of the marginalised indigenous crop and plant varieties. Such a policy can also help address the constraints that hinder or affect NUCS cultivation and use in Ghana **[F].** This is critical particularly due to the key contributions of NUCS in the attainment of food security (Nyadanu *et al*., 2014; Magbagbeola *et al.*, 2010).

2.8.2 Theoretical Framework

Although a number of different theoretical positions can contribute to an understanding of this study, the Resource-based theory is used. This study draws on the core propositions of the Resource based Theory (RBT) and uses it as a lens in understanding how NUCS as a valuable resource can be used in addressing household food insecurity.

2.8.2.1 Resource-Based Theory (RBT)

The Resource-based Theory (RBT) is widely acknowledged as one of the most prominent theories in the history of management theorizing. The origin of the theory dates back to the work of David Ricardo in the 19th century (William *et al*., 2011) even though other schools of thought (Habbershon and Williams, 1999) have indicated that the Resource based view (RBV) first appeared in the work of Bernard in1938 (Conner, 1991). Another school of thought also attributes the origin of the concept to the contributions of Selznick in 1957 (Bryson *et al.*, 2007), Penrose in 1959 (Nair *et al*.,2008) Pfeffer and Salancik in 1978 (Hillman *et al.*, 2009), Rumelt in 1984 (Madhani, 2010); Wernerfelt (1984), and Habbershon and Williams, (1999).

The core proposition of the RBT is that resources are critical if a firm has to or seeks to achieve a sustained competitive advantage (Barney, 1991, 2002). Barney *et al.* (2011) described these resources as tangible and intangible assets, such as a firm's management skills, its organizational processes, information and knowledge it controls that can be used to implement strategies. The key characteristics of such resource as proposed by Barney among others, is that, it must be valuable and be able to present opportunities or neutralizes threats in a firm's environment.

Additionally, it must be rare among a firm's current and potential competition (Almarria & Gardinera (2014).

The theory like many other theories has transitioned and undergone evolution from a Resource based view (RBV) to Resource based Theory (RBT) due to the contributions of many other scholars. The theory though widely used and recognized has also been critiqued, citing various limitations and weaknesses. Almarria and Gardinera (2014) analysed and identified the limitations: definitional flaws; generalizability, and construct validity. Sanchez (2008) in a scientific critique of the theory also identified some fundamental conceptual deficiencies and logic problems particularly in Barney's conceptualization of "strategically valuable resources" and in Barney's VRIO (Value, Rarity, Imitability, Organization) framework for identifying strategically valuable resources that can be sources of sustained competitive advantage. Among the logic problems identified include the value conundrum, the tautology problem in the identification of resources and the absence of a chain of causality. Sanchez further argued that the core proposition of the theory which describes resources as the source of sustained competitive advantage was flawed as it precludes use of the scientific method in Resource Based View (RBV) research.

Among the key contributions that significantly influenced the RBT was that of the work of Edith Penrose in the 1950's. According to Penrose a firm's resources influence its growth and therefore the absence of adequate resource will hinder or constrain the growth or development of a firm (Nair *et al*., 2008). Penrose further notes that a firm can create economic value and be successful if it is able to utilize or manage the resources it possesses effectively and innovatively (Mahoney, 1995). In other words, sustainable development can only be achieved by the effective

and efficient employment of all resources available to a state (Mahoney, 2011). The theory therefore emphasizes on the peculiarity of the internal resources of a firm as an advantage (Habbershon & Williams, 1999; Pablo *et al.,* 2007), additionally it also serves as a strategic management framework for the effective management of the resources available to a person or state.

The underlying principles of the RBT as relates to the use of "internal resources" makes it appropriate for this study as it provides an understanding of the need to exploit indigenous plant resources such as NUCS that are currently marginalised and underutilized in Ghana, for the purposes of helping address household food insecurity in Ghana. While the internal resources of a firm according to the RBT is vital to the achievement of a competitive advantage, NUCS as plant genetic resources available to farmers and agricultural practitioners are also critical to addressing important national issues such as food insecurity particularly among indigenous communities in the country. According to Penrose a firm can create economic value if it is able to effectively exploit and utilize the resources it possesses, likewise farmers or broadly the agricultural sector in Ghana can significantly address the challenges of food insecurity among local or rural households if there is a deliberate strategy and plan to integrate and effectively exploit the potential of the resource called NUCS which are currently available but untapped. Barney also suggests that a resource must have the unique characteristic of being valuable and able to present opportunities. NUCS in this respect constitute a valuable plant genetic resource particularly given their nutritional, ecological, medicinal and economic benefits or properties.

Eniola and Entebang (2015) also argue that the possession of more underutilised crops by a state does not alone result in the creation and maintenance of economic value, rather, the effective and

innovative use and management of such crops and species. The availability of other supporting resources such as effective agronomical practices, farm inputs, and the technology for cultivating underutilised crops are all essential for the full utilisation of underutilised crops. The theory finally also helps us to understand why farmers should be resourced to build their capabilities in order to be able to cultivate more of NUCS thereby promoting their use.

2.9 Study propositions

The underlying propositions that have informed the study are as follows:

1. Most indigenous food crop varieties that could potentially help address food insecurity in rural households in the Upper Afram and Upper Dayi basins are being marginalized and underutilized;
2. Prevailing agricultural practices are affecting the cultivation and use of NUCS;
3. Environmental and socio-economic factors are influencing the cultivation and use of NUCS in Central Ghana.

2.10 Research gap

- There currently exists a gap in the theoretical knowledge of the environmental and socio-economic factors influencing NUCS cultivation and use in some of the agrodiverse areas of the country particularly, the Upper Afram and Upper Dayi basins. This research effort will address this knowledge gap.

- This research will help fill the existing gap in academic literature on the varieties and uses of NUCS in the middle belt of the country. The study will produce an inventory of NUCS in the Upper Afram and Upper Dayi basins.

CHAPTER THREE

RESEARCH APPROACH AND STUDY METHODOLOGY

3.0 Introduction

This chapter provides a general description of the study areas, research approach and methodology for the study. The section is presented in two parts: the study area and the research approach and methodology.

3.1 Study areas

This study focused on two river basins, the Upper Afram in the Ashanti Region and the Upper Dayi basin in the Volta Region, within the middle belt region of Ghana.

3.2 Justification for choice of study sites

The two study sites, the Upper Afram and Upper Dayi basins were chosen for the study due to the unique history of intense agricultural activity among the local communities within the two basins. Most communities within the basins comprise of farming households with similar agricultural history and are actively engaged in food crop production. For example, inhabitants of Likpe, one of the study communities in the Upper Dayi basin are known to have migrated alongside other Guan groups and settled in Atebubu in the Brong Ahafo Region in the Afram basin. The inhabitants of the two basins therefore share some common farming practices. Another important factor for the choice of the study areas is the rich agrodiversity and the high level of rainfall experienced in the areas accounting for the wide variety of food crops and plant species in the areas. Ejura Sekyedumasi and Hohoe are two municipalities that also fall within

the Upper Afram and Upper Dayi basins respectively that are known for their dynamic agricultural markets. The agroecological zonation within which the two basins fall also informed the choice of the study sites. The Upper Afram basin is located within the Forest Savanna Transition zone whilst the Upper Dayi basin lies within the Semi-Deciduous Rainforest of Ghana (Figure 3.1). The presence of the Dayi river also serves as a major water source for irrigation for food crop production. The two study areas also constitute the major food basket of the nation and therefore are under high influence of market forces due to the large agricultural markets.

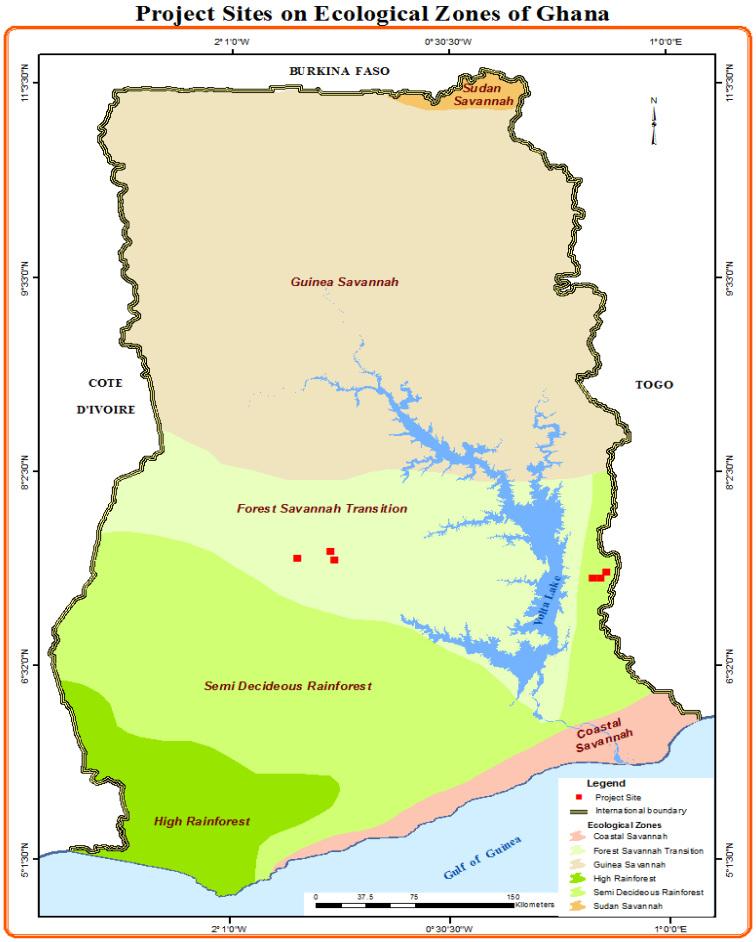


Figure 3.1: Project sites on Ecological zones of Ghana

3.3. Upper Afram Basin

3.3.1 Physical characteristics

- Location

The Afram basin (Figure 3.2a) covers nine districts namely, Kwahu South; Kwahu North; Kwahu East and Fanteakwa all in the Eastern Region of Ghana. The others are Sekyere Central; Mampong Municipal; Sekyere East; Sekyere Afram Plains and Ejura-Sekyedumasi all in the Ashanti region of Ghana. The Afram River which is about 90 km long rises from Mampong in the Ashanti region and flows southwards into the Volta Lake. The river served as a tributary of the Volta River prior to the construction of the Akosombo dam in 1960. The river also receives nearly all the drainage of the Kwahu Plateau. The river valley has a very flat terrain. This is often flooded and swampy. The lower Afram serves as a busy arm of the impounded Volta Lake, aiding as an important waterway. The primary activity among inhabitants around the basin is farming. Among some of the crops cultivated around the basin include maize, rice, plantain and tuber crops. Fishing activities also take place along the basin.

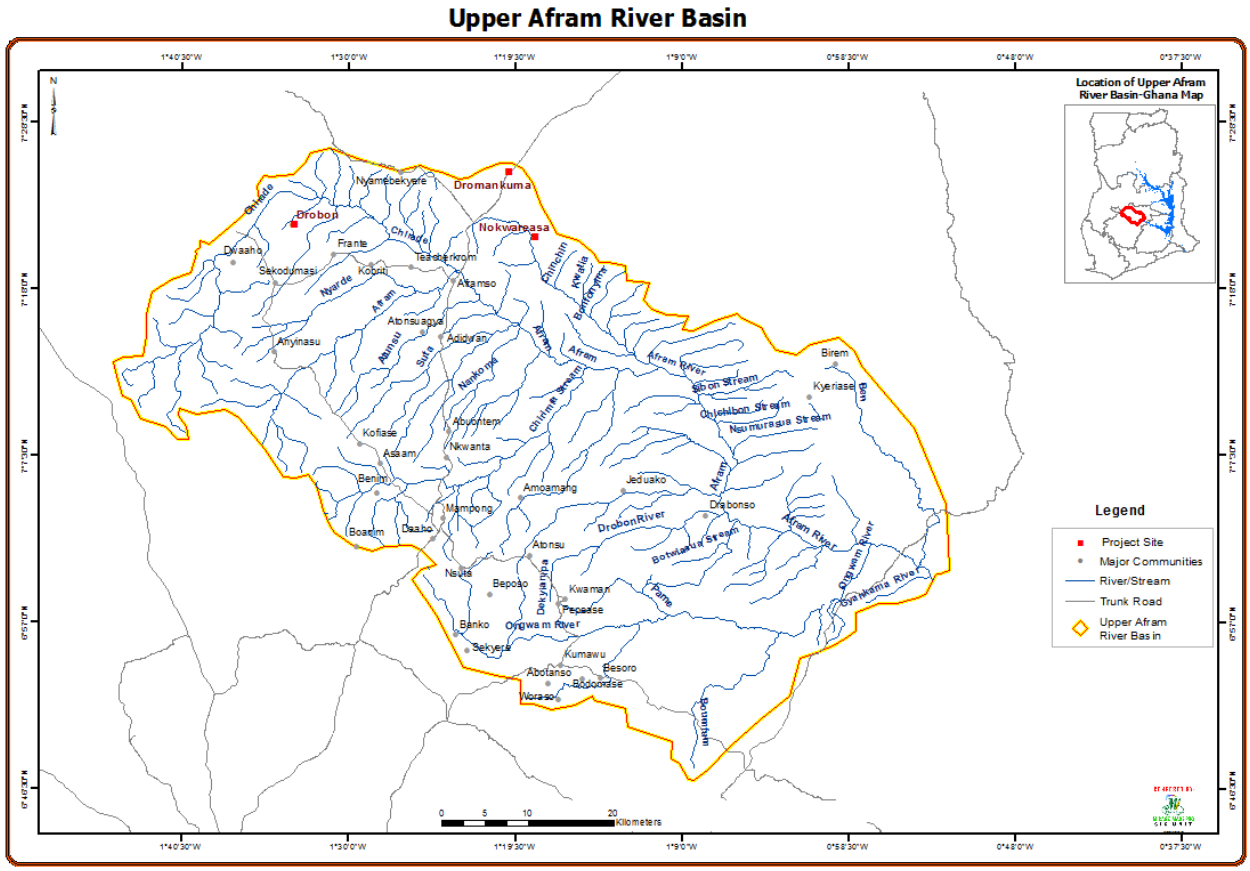


Figure 3 2a: Upper Afram Basin *Source: CERGIS*

- Agro-ecological zonation

The Food and Agriculture Organization (FAO, 1996) defines an agro-ecological zone as a land unit whose classification is informed or based on factors such as climate, landform and soils or land cover; and also possesses specific range of potentials and constraints for land use. Agro-ecological zones in Ghana are defined in terms of climate, the natural vegetation and the soils. Whilst different categorizations have been observed in literature in terms of the number of Ghana's agro-ecological zones, the Ministry of Food and Agriculture notes six ecological zones in Ghana (MoFA, 2009). These are the Semi-Deciduous Rainforest; Forest Savanna Transition; Sudan Savanna; Guinea Savanna; High Rainforest and Coastal Savanna.

The Upper Afram basin area falls within the Forest-Savanna Transition Zone of Ghana. The Forest Savanna Transition zone can be found within the middle portion of Brong Ahafo region, the northern part of both Ashanti and Eastern regions and the western part of Volta region. This zone is considered as the food hub of the country and hence offers a great potential for increased food productivity.

- Climate

The basin has an annual average temperature of about 28^{o}C (Ayivor *et al*., 2016) with average annual rainfall ranging between 1200mm and 1300mm. The rainfall is under the influence of the movement of Inter Tropical Convergence Zone (ITCZ), a low-pressure zone where north-moving and south-moving air masses meet north of the equator in the Sub-Saharan African region.

- Relief and Drainage

The landscape of the catchment is underlain by the Voltaian sandstones, shales and granite. It is characterized by the presence of ironstones concretions (iron pans) at generally shallow depths lying below the surface of the soil. The soil types found in the catchment vary from Savanna Ochrosols to Forest Ochrosol. The soils of the forest are loamy and liable to dry out quickly while those in the savanna are soft and liable to alternate flooding and drying as a result of the flat-bedded sandstone rocks near the surface (Wildlife Department, 1994; Yidana, Ophori & Banoeng-Yakubu, 2008). The Afram River and its tributaries drain the south into Lake Volta to the east. The topography of the area is generally low-lying (Appendix A).

3.3.2 Socio-economic

- Political administration

The basin in terms of political administration is under the jurisdiction of Kumawu and Kwamang traditional areas in the Ashanti Region of Ghana. Its population is made up of largely indigenous Asante and migrants from the northern parts of Ghana (Ayivor & Ntiamoa-Baidu, 2015).

- People

The Ejura-Sekyedumasi Municipality within which the study communities were selected also lies within the Upper Afram basin. It has a total population of 85,446 representing 1.8 percent, with males constituting 50.2 percent whilst females represented 49.8 percent according to the 2010 Population and Housing Census. About 74.6 percent of the population aged 15 years and above are economically active while 25.4 per cent are not. Of the economically active population, 97.4 percent are employed of which about 60.2 percent are engaged in fishery, skilled agricultural and forestry activities. About fifty (49.7) percent of the population is rural. In the rural localities, eight out of ten households (85.9%) are agricultural households with most households (97.4%) involved in crop farming (GSS, 2014a).

3.3.3 Study communities

The study communities within the Upper Afram basin consisted of Nokwareasa, Dromankuman, and Drobon (Figures 3.2b; 3.4). These communities fall within the Ejura Sekyedumasi Municipality of the Ashanti Region. Communities in this study area comprise mainly agricultural households and therefore were mostly engaged in crop farming. The inhabitants who are mostly

farmers also possessed good historical memory of the agricultural patterns and practices of the area. Within the municipality is the extensive practice of commercial agriculture with high monocultural practices involving mainly maize production. Ejura has the largest market centre in the municipality, Ejura Central Market. Its market day is Monday during which farmers from all over the municipality and beyond come to market their produce.

- *Nokwareasa*

This community is located between Latitude 7^0 21' 13" N and 7^0 21' 23" N, and Longitude 1^0 18' 13''W and 1^0 18' 22" W within the middle part of Ejura in the Upper Afram basin. It is a mix community with inhabitants comprising mainly of indigenes and some settlers. It has a population of 239 inhabitants made of 135 males and 104 females (GSS, 2014a). Inhabitants of this community are mostly farmers who are engaged in the cultivation of crops such as maize, plantain, beans, groundnuts as well as livestock production. The lands available for farming in this community consist mainly of long slopes which are affected by severe erosion. In this community, Wednesdays are considered to be the sacred or "taboo" days during which farming activities are not allowed.

- *Dromankuman*

This is a settler community located between Latitude 7^0 25' 10" N and 7^0 25' 37" N, and Longitude 1^0 19' 43''W and 1^0 20' 15" W within the Upper Afram catchment. The community is dominated by settlers from the northern regions of the country who migrated into the area to explore economic opportunities mainly farming. It is a farming community with a population of

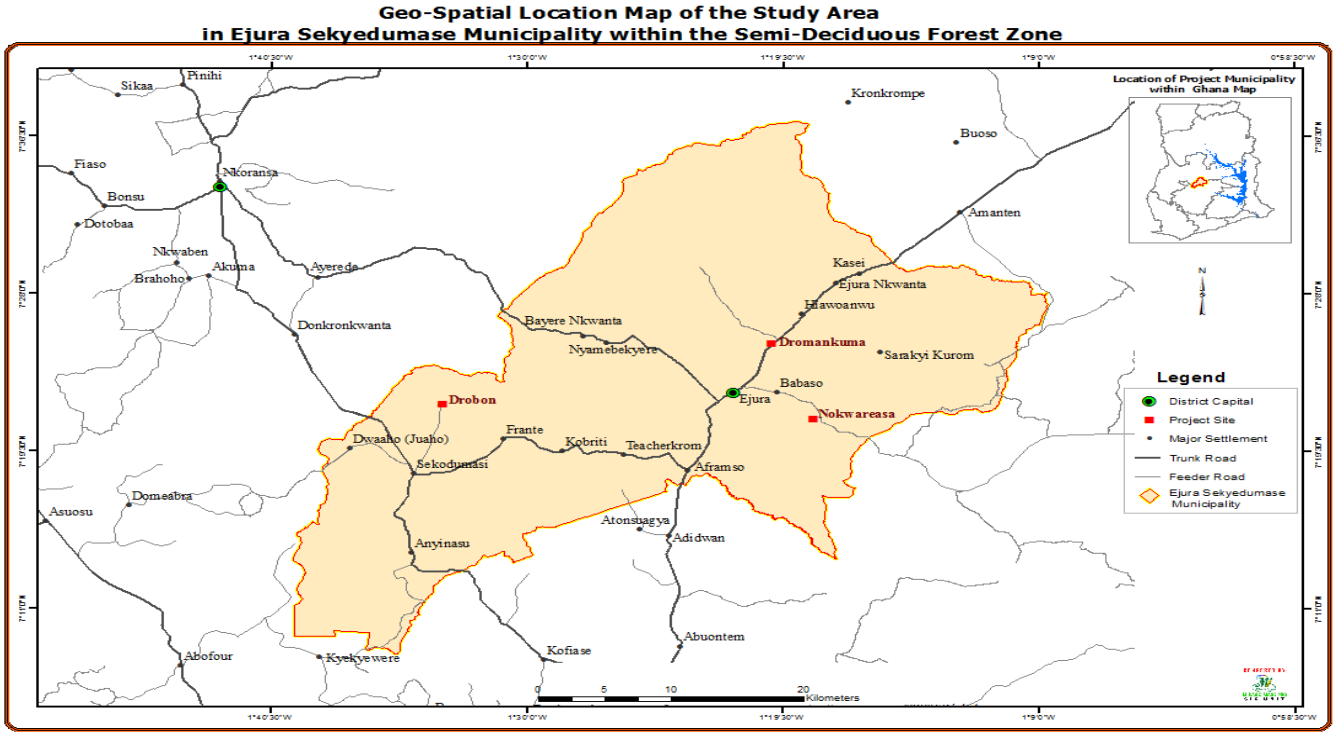


Figure 3.2b: Study sites in the Upper Afram Basin ***Source: CERGIS***

2, 334 people comprising 1,183 males and 1,151 females (GSS, 2014a). This site also represents the northern part of Ejura. Farmers in the community are mostly maize cultivators.

- *Drobon*

This is a typical Ashanti community located between Latitude 7^0 22' 0.00" N and 7^0 22' 13" N, and Longitude 1^0 33' 22''W and 1^0 33' 35" W within the Afram catchment. This study site therefore constituted a homogenous sample. Inhabitants of this community are mainly indigenous farmers with a population of 999 inhabitants comprising 499 males and 500 females (GSS, 2014a). Agro diversity in this area is quite high and therefore diverse crops can be found in the area compared to other communities in Ejura and its environs. This site represents the southern part of Ejura.

3.4 Upper Dayi Basin

3.4.1 Physical characteristics

- Location

The Dayi River Basin (Figure 3.3a) is one of the sub-basins of the Volta River system; and is located between latitude 7° 19' N - 6° 38' N, and longitude 0° 39' E -0° 17' E in the Volta Region. It covers an area of about 1,544 km^2. It is bounded by the Volta Lake to the West and in the East by the Togo border. The north is bounded by the Asukawkaw Basin and to the south and south east by the Volta Lake, Alabo Basin and Todzie Basin. The Dayi River takes its source from the Akpafu range in Togo and drains through the low-lying portion of the Hohoe municipality until finally discharges into the Volta Lake in the Kpando District (WRC, 2011).

- Agroecological zonation

Upper Dayi basin falls within the forest agro-ecological zones of the Ewe-Buem mountainous region which is characterized by elongated ridges and valleys aligned in southwest to north east direction. The Dayi river flows through Semi-deciduous Forest, Savanna, and Mountain Vegetation. The basin had a moist semi-deciduous and rainforest with thick undergrowth and closed canopy but this native forest ecology has been greatly modified due to anthropogenic activities. The Dayi basin currently consists of two vegetation types. The north-western and eastern section of the basin is forested land. The forest consists of closed canopy of branches and little undergrowth. It is found on the slopes of the Akwapim-Togo-Attakora ranges. The northern section of the basin on the other land is savanna woodland covered with grass and scattered trees like Acacia, Bamboo and Baobabs.

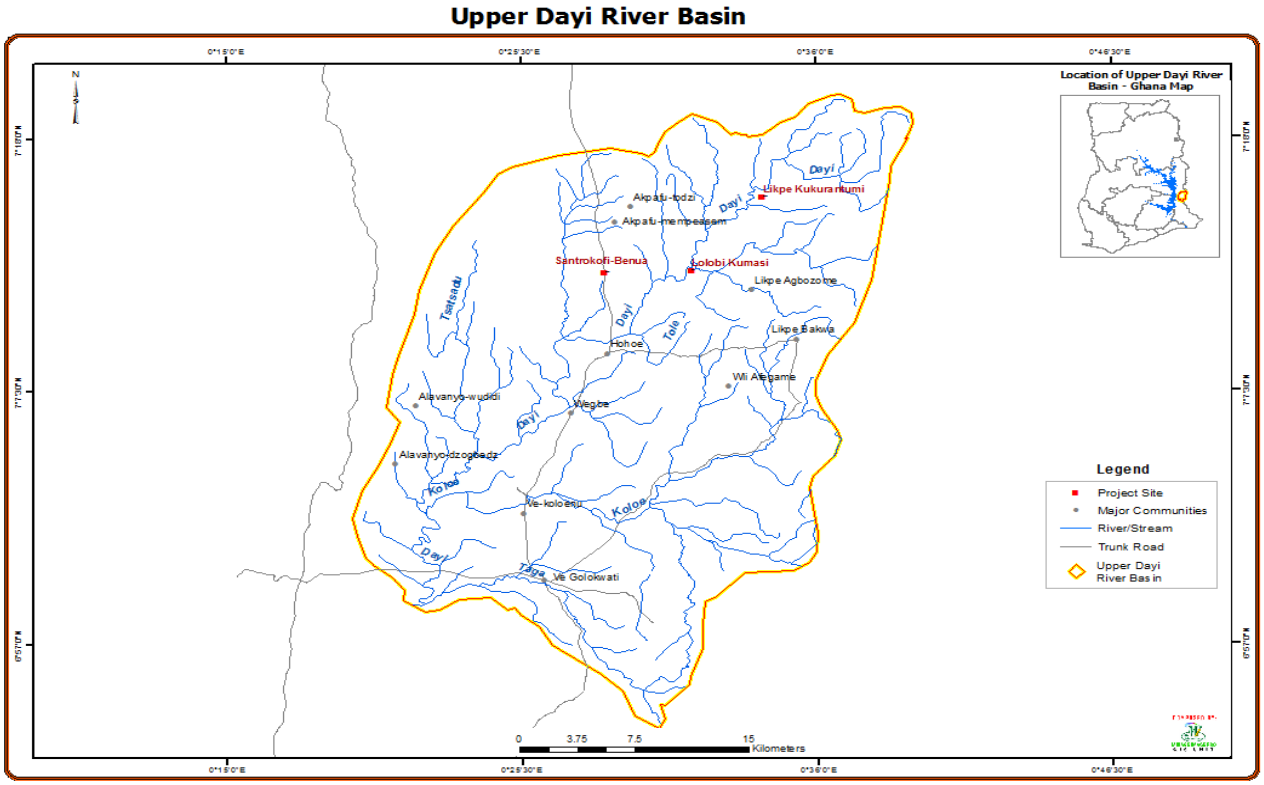


Figure 3 3a Upper Dayi Basin *Source: CERGIS*

- Climate

The basin is characterized by a bi-modal rainfall regime with the major rainy season starting from mid-April to July and the second minor season occurring between September and November with October in some instances recording the highest of the two peak rainfall regimes. The basin has a tropical climate which is influenced by the southwest monsoon wind from the South Atlantic Ocean and dry harmattan winds from the Sahara Desert. The Dayi Basin is characterized by uniformly high temperatures throughout the year with a mean annual temperature of about 26°C. March is the hottest month in the basin with a mean monthly temperature of about 28°C and September the coolest with a mean temperature of about 25°C (WRC, 2011).

- Geography (Relief and drainage)

The basin has several highlands and adjacent lowlands, scattered hills and ranges of varied lengths and heights (Appendix B). The Afadjato and the Akwapim- Togo-Atakora ranges are both located within the catchment. Waterfalls such as the Wli and Tsatsadu falls and swamps are also found in the basin. The Dayi River and its tributaries constitute one of the major water sources for domestic, irrigation and industrial purposes. Soils found in this basin are mainly the forest and savanna ochrosols. The vegetation within the basin comprises the moist semi-deciduous forest, savanna and mountain vegetation.

3.4 2 Socio-economic

- Political administration

The Dayi basin is located within the Volta Region covering five districts/municipals: Jasikan District, Kpandu District, South Dayi District, Hohoe Municipality and Ho Municipality. The Hohoe Municipality covers an area of about 72% of the basin with Jasikan district covering 6%, Kpandu about 17%, Ho Municipality 4%, and South Dayi district 1%. As an average for the entire Dayi Basin, the population density (year 2000) is 86 pop/km^2 (WRC, 2011).

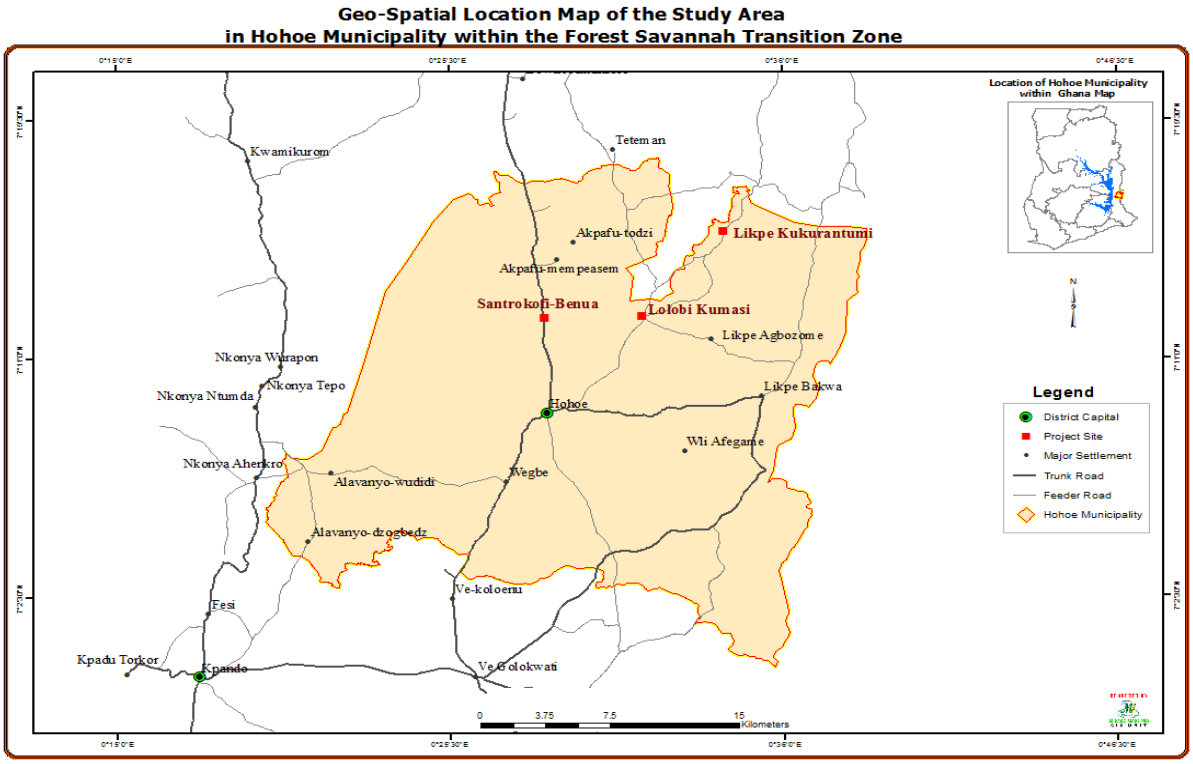


Figure 3.3b Study sites in the Upper Day Basin *Source: CERGIS*

- People

The Dayi Basin is a rural and relatively densely populated area. The Hohoe municipality within which the study communities were selected forms a major part of the basin with a population of 167,016 (2010 population census) constituting 7.9 percent of the total population of the Volta Region. It has an urban population of about fifty-three (52.6%) percent with sixty-six percent of persons aged 15 years and older being economically active while 33.6 percent are not. Of the economically active population, 96.0 percent are employed of which about 38.7 percent are engaged as forestry, skilled agricultural and fishery workers. More than half (57.4%) of households in the municipality are engaged in agriculture. In the rural localities, six out of ten households (65.3%) are agricultural households with most households (91.1%) involved in crop farming (GSS, 2014b).

3.4.3 Study communities

The study communities within the Upper Dayi basin consisted of Likpe-Kukurantumi, Lolobi-Kumasi, and Santrokofi-Benua (Figure 3.3b; 3.4). These communities fall within the Hohoe Municipality of the Volta Region. Communities in this study area are homogeneous and were selected due to their proximity to the Dayi River. For each of the cluster traditional areas, the three selected communities were the closest to the river basin which could be a source of water for agricultural activities. Hohoe municipality is also known for commercial mono farming practices with mainly cocoa and rice cultivations.

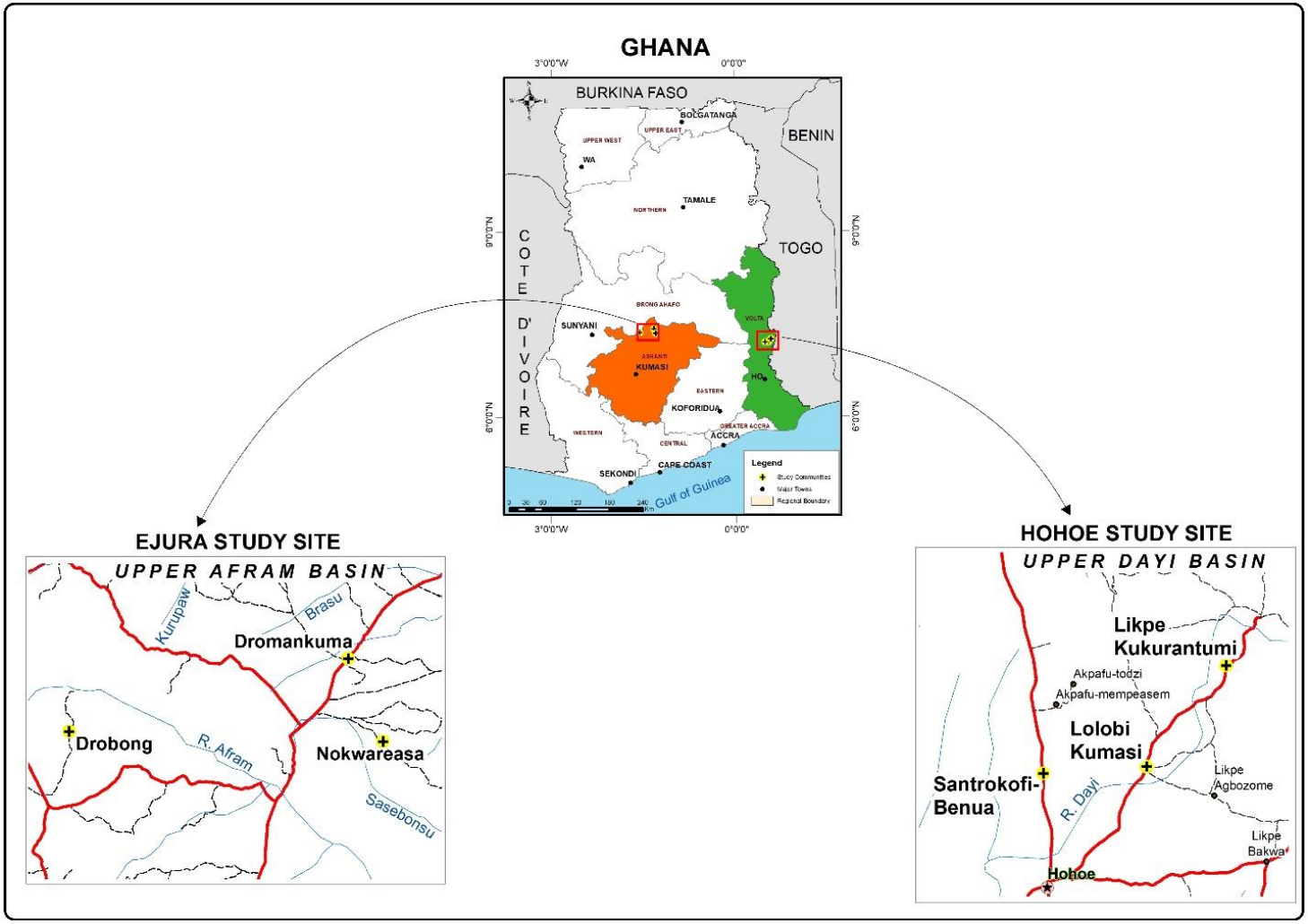


Figure 3.4 Map of Study Areas showing the location of study communities *Source: CERGIS*

Though there are small markets in almost every community, Hohoe has the largest market, Hohoe Central Market which receives much patronage on Mondays and Fridays, its market days.

- *Likpe-Kukurantumi*

This is a farming community located between Latitude 7^0 15' 20" N and 7^0 15' 45" N, and Longitude 0^0 33' 55''E and 0^0 34' 15" E in the Likpe traditional area in the Hohoe District of the Volta Region. Likpe can be found in the well drained upper slopes of the Dayi basin. The Likpe traditional area comprises twelve communities with inhabitants of diverse backgrounds. The community was discovered by the people of Bakpale. The indigenous language of the people of the community is Sakpale. The community has a population of 1,707 people comprising of 845 males and 862 females (GSS, 2014b). The main economic activity in the area is farming, and the inhabitants cultivates crops such as rice, cocoa, plantain and cassava.

- *Lolobi-Kumasi*

Lolobi-Kumasi is located between Latitude 7^0 12' 20" N and 7^0 12' 50" N, and Longitude 0^0 31' 20''E and 0^0 31' 45" E at an elevation of 250 m above sea level. It is located within the Upper Dayi Basin in the Volta region. Inhabitants of the Lolobi and Akpafu originally were one ethnic group and therefore spoke the same language. It has a population of 2, 317 inhabitants comprising 1,112 males and 1205 females (GSS, 2014b). The people were previously iron ore smelters and manufactured their own local guns. Currently, inhabitants are mainly rice and cocoa farmers. Some rice farmers even migrate seasonally to other nearby communities for the cultivation of their rice.

- *Santrokofi-Benua*

Santrokofi is paramouncy with its own language and culture. The indigenous people of this area are known as Balee and speak the language known as Salee. People of this area are of Guan extraction. It comprises three townships, Benua, Bume and Gbodome. Santrokofi Benua is one of the three communities in the Santrokofi traditional area in the Hohoe municipality. It is located between Latitude 7^0 12' 10" N and 7^0 12' 35" N, and Longitude 0^0 28' 15''E and 0^0 28' 35" E and shares common boundaries with Akpafu to the north and Lolobi to the east. The community is situated three kilometers from Hohoe, on the north-south eastern trunk road from Accra to Kadjebi and beyond. The inhabitants of this community are mainly farmers and hunters. It has a population of 3, 702 people comprising 1, 682 males and 2, 020 females (GSS, 2014b).

3.5 STUDY METHODOLOGY

This section describes the research approach and methodology that were employed in conducting the study. It outlines the sampling method, data collection and survey instruments and the analytical techniques and tools used for the analysis.

3.5.1 Sources of data

Data was gathered from two main sources namely primary and secondary. The primary data were obtained through administration of questionnaires and interviews (key informant interviews and focus group discussions). The respondents comprised of farmers, agricultural scientific researchers, farmer-based organizations and market women and men. The sources of secondary data included articles from journals, newsletters, annual reports, presentations at key conferences, annual statistics textbook and internet sources and climatic data (from the headquarters of the Ghana Meteorological Agency) for the Upper Afram and Upper Dayi basins, specifically Ejura, Jasikan and Hohoe municipalities within which the study communities were selected.

3.5.2 Sampling method

The study employed both qualitative and quantitative research approaches. Creswell (2009) describes qualitative research as a research approach that seeks to explore and understand the meaning individuals or groups ascribe to a phenomenon. The quantitative method on the other hand employs numbers to explain research findings. According to Creswell (2003) quantitative research helps to collect data or information using instruments that yield statistical data. The qualitative method was used to collect and capture rich descriptions of the phenomenon through

the experiences of the respondents on the marginalization and erosion of the local crop varieties, as well as the implications for household food security. The quantitative method on the other hand was used to collect information to supplement the qualitative data.

3.5.3 Sampling Technique

This study employed a non-probability purposive sampling technique. This method was deemed appropriate for this study given the focus of the research which was to reach a specific group of the population, the farmers, who were involved in crop farming and possessed the relevant knowledge on the subject under study.

3.5.4 Reconnaissance visit

A reconnaissance visit was made to each of the two basins where the study communities were identified and selected with the assistance of the district agricultural extension officers of MoFA. Field assistants were also contracted and adequately trained on the data collection procedures and questionnaires in order to ensure reliable data for analysis. The main goal and purpose of the research study were also discussed with the key stakeholders and their express consent sought.

3.5.5 Sample size

Target population comprised Adult farmers (40 years and above) who were either settlers (for not less than 10 years) or natives of the community; Research Scientists from the Crop Research Institute and the Plant Genetic Resources Institute of the Council for Scientific and Industrial Research; Officials from MoFA; Executive members of Farmer based organizations including the United Farmers Association; Kasapa Farmers Association; the Vegetable Growers

Association and Food crop sellers and marketers such as the Yam sellers association; market women from Ejura and Hohoe; and an individual marketer. The choice and selection of respondents was based primarily on the length of stay of respondents in the community. Indigenes were therefore targeted particularly due to their prolonged stay in the community and their tendency to possess a good historical memory of the patterns of agricultural practices of the area. The total sample size for the study was two hundred and seventy one (271) comprising two hundred and forty (240) Farmers; Two (2) Crop Research Scientist from Crop Research Institute and Plant Genetic Resources Research Institute, CSIR; Four (4) officials from MoFA; (20) Market women/men; One (1) Individual Marketer (food crops); One (1) from United Farmers Association; One (1) from Kasapa Farmers Association; One (1); from Vegetable Growers Association and One (1) from the Yam Sellers Association (Table 3.1).

Table 3.1: Overview of methods of data collection, respondents involved and number of interviews and questionnaires administered

No	Respondents	No of Respondents	Method of data Collection/Instrument Used	No of Interviews/ Questionnaire Administered
1	Farmers	240	Questionnaires (One -on- one) 40 questionnaires per 6 communities	240 Questionnaires;
			Focus Group Discussions (two discussions per 6 communities; 8 -10 farmers per group)	12 Focus Group Interviews
2.	Ministry of Food and Agriculture - MoFA officials	4	Key Informant Interview (two per 2 study basins)	2
3	**Crop Research Scientists from**			
	a) Crops Research Institute, CSIR	1	Key Informant Interview	1
	b) Plant Genetic Resources Research	1	Key Informant Interview	1

	Institute, CSIR			
4	**Food crop Sellers/Marketers**			
	a) Individual Marketer	1	Key Informant Interview	1
	b) Market Women	20	Key Informant Interview	20
	c) Yam Sellers Association	1	Key Informant Interview	1
5	**Officials from Farmer Based Associations**			
	a) United Farmers Association	1	Key informant Interview	1
	b) Kasapa Farmers Association	1	Key informant Interview	1
	c) Vegetable Growers Association	1	Key informant Interview	1
Total		**271**		

3.5.6 Respondents

- *Farmers*

Farmers involved in food crop cultivation with over ten years of experience in farming were the target of the study and therefore constituted the primary respondents. This was important since such respondents were likely to possess relevant information on the agricultural crop production patterns, local knowledge and history of farming practices of the area. The farmers engaged in the study comprised of both males and females. They were identified in the study communities with the assistance of the agricultural extension officers from the MoFA offices and other community leaders in the two study basins. Farmers in the study communities within the Upper Dayi basin were mostly indigenes whilst those in the Upper Afram basin comprised both indigenes and settlers.

- *MoFA Officials*

Officials from the Ministry of Food and Agriculture (MoFA) offices in Ejura in the Upper Afram basin and Hohoe in the Upper Dayi basin were engaged in the study mainly as key informants. MoFA is a government institution with a mandate to promote sustainable agriculture and thriving agribusiness through research and technology development, effective extension and other support services to farmers, processors and traders for improved livelihood (MoFA, 2017). Engaging the officials was important to the researcher particularly because they were more likely to possess and provide relevant information on the historical records (institutional memory) of agricultural food production, agronomic practices and other related issues in the study communities. The officials interviewed included the directors and crops officers of the MoFA offices in the two study areas. Both directors had been at post for less than three (3) years at the time of the interviews and so technical questions relating to the communities were handled by the crops officers. The crops officers who had stayed and worked with the farmers in the communities for much longer periods provided useful insights during the interviews.

- *Crop Research Scientists*

Crop research scientists from two major institutions under the Council for Scientific and Industrial Research namely the Crops Research Institute (CRI) at Ejura in the Ashanti Region and Plant Genetic Resources Research Institute (PGRRI) at Bunsu in the Eastern Region were visited in connection with this study. CRI and PGRRI both have broad research mandates over crops and plant genetic materials in Ghana. The perspectives of experts with technical knowledge on underutilized crop species; plant genetic diversity and conservation as well as the

existing policy provisions promoting them was important to the researcher; hence the decision to engage them as key informants of the study.

- *Market women*

Engaging food crop sellers, market women in the major markets within the study basins was important. Food crop sellers could give a sense of the food crops available on the market. They could also give an indication of the food crops that are either no longer on the market or in low demand due to various reasons. This market survey which comprised both key informant interviews and observations sought to gather information on such crops and also generate an inventory of the food crops that were presently unavailable on the market as well as some of the possible factors accounting for the situation. Twenty market women were interviewed; ten each from the Ejura and Hohoe Central markets all located within the Upper Afram and Upper Dayi basins respectively. In Ejura for example the survey was conducted on a Monday which was a market day. A similar exercise took place at Hohoe whose market days were Mondays and Fridays.

- *Farmer Based Organization (FBO) Officials*

Officials from farmer-based organizations (FBO) and associations such as United Farmers Association; Kasapa Farmers Association; Vegetable Growers Association; Yam Sellers Association and Individual/freelance Marketers (food crops) were engaged in this study. Interacting with the executive members of the FBOs provided the researcher further insight into the general food crop cultivation, utilization, and marketing within the study communities. The FBOs were identified with the help of the agricultural extension officers in the MoFA offices in

the two study basins. Three key informant interviews were conducted for all the FBOs, with each FBO being represented by an executive member.

3.5.7 Survey and data collection instruments

In order to elicit the relevant data from the respondents, the following data collection instruments were used: questionnaire; focus group discussions; key informant's interviews; (Appendices E, F, G, H, I, and J) and on-the-spot observations.

3.5.7.1 Questionnaire administration

This study employed a questionnaire that contained both closed ended and open-ended questions. This type of questionnaire was chosen in line with the objectives of the study which was to collect both qualitative and quantitative data. The questionnaire which comprised various sections was developed based on the study objectives. The questionnaire consisted of eight sections. Sections A and B focused primarily on the socio demographic characteristics of the respondents. Section C and D covered questions on food crop cultivation and farming systems in the study areas. Section E captured information on the knowledge and uses of underutilized crops; while section F focused on the environmental issues including climate change, strategies and factors influencing the cultivation or erosion of underutilized crops. The last two sections G and H elicited responses on Household food security including household income and expenditure. A sample of the questionnaire can be found in Appendix (E).

Prior to the start of the field work, it was important to conduct a pilot or pre-test of the questionnaire. This pre-test survey was carried out in a farming community named *Nkruakan*. It is a community in the Yilo Krobo district of the Eastern region. The respondents were mainly

farmers. The exercise was conducted by the researcher. The objective was to test the clarity of the questions outlined in the questionnaire with the view to fine tuning and improving the content of the questionnaire.

- Data collection using questionnaires

Prior to the data collection, visits were made to the six study communities to identify the farmers who constituted the primary respondents. In these introductory visits the researcher with field assistants and agricultural extension officers from MoFA offices within the study communities in the two basins met the community leaders to seek their consent before undertaking the study. During these meetings the community leaders were briefed on the purpose and goals of the research. The farmers engaged in the study comprised both males and females.

Questionnaires were administered to the farmers through interviews instead of the usual self administration by respondents. This approach was necessary due to reasons such as the lack of reliable postal services in the communities and also, most of the farmers had little or no education. The questionnaires were administered to the respondents in all the study communities. The farmers in this study constituted a very important target audience. Individual farmers with over 10 years' experience and actively engaged in farming were purposely selected. The respondents were either indigenes or settler farmers who had stayed in the community long enough to possess agricultural history and farming practices of the area. In each household respondent were chosen based on the individual that the household deemed fit and possessed the relevant agricultural knowledge particularly food crop production patterns, underutilized crops; the traditional knowledge and history of farming practices of the study communities in which they lived.

Though the questions were in the English language, it was translated into the local dialect of the people to facilitate comprehension. The exercise was carried out mainly in English and Twi. However, where it was necessary translations were done from English to either Twi or Ewe. Due to time constraints and the number of respondents involved in the study it was necessary to engage field assistants in the questionnaire administration process. The questionnaire administration for each farmer lasted about one and a half hours.

3.5.7.2 Focus Group Discussions

Focus group discussions (FGDs) were used in this study in line with the objectives of the research. FGDs were deemed appropriate for the study due to the platform it provides for dynamic interaction between researchers and participants often resulting in the gathering of rich data. A sample of the questions for the FGD can be found in Appendix (F).

- Data collection using Focus Group Discussions

Two focus group discussions were held in each of the three communities in both study areas. Each focus group comprised ten (10) respondents, mainly farmers who were above forty years with over ten to twenty years of experience in farming or crop production and possessed good memory of the agricultural history of the area. Each group comprised males and females even though the males usually dominated the groups (Plate 3.1a and b). The tendency for the males to also dominate the discussions was tactfully managed by the researcher as the females were encouraged to also actively engage. But respondents were generally encouraged to freely express their views and opinions. The questions for the focus group discussions were generated based on extensive study of secondary data. Responses elicited from the respondents were carefully

documented with the help of the field assistants. Each interview lasted between one and half hours and two hours. The interview sessions were audio recorded upon express consent from the respondents in order to capture information or responses that could not be captured during notes taking.

3.5.7.3 Key informant interview

In this study key informant interviews were conducted (Plate 3.2). This instrument was chosen and deemed appropriate to gather the perspectives of other identified respondents known as key informants who possess relevant information on the subject of study. Sample of the various interview guides can be found in Appendices (G, H, I and J).

- Data collection using interview guide

Individual face to face interviews were conducted using interview guides to elicit information from key informants comprising market women and officials from selected institutions and organizations such as MoFA; CRI; PGRI; United Farmers Association; Kasapa Farmers Association; Vegetable Growers Association and the Yam Sellers Association. Prior to the individual interviews, appointments were scheduled with all the identified key informants after which the purpose of the research was discussed. The individual respondents' roles, information, confidentiality, voluntary participation and right of withdrawal were also communicated. Interviews were conducted at agreed locations in the offices and market places of the respondents. Each interview lasted between forty-five (45) minutes and sixty (60) minutes depending on the respondent.

Plate 3.1a: Some Focus Group Discussions with local farmers in study communities in the Upper Afram Basin

Plate 3.1b: Some Focus Group Discussions with local farmers in study communities in Upper Dayi Basin

Plate 3.2: Key informant interviews in study communities in the Upper Afram and Upper Dayi Basins

3.5.7.4 On- the- Spot Observation

As part of efforts to familiarize and understand the way of life of the people and to interpret their comments, the researcher attended some local events and visited local markets including other places of interest to observe some activities and practices. Observations were made using observational protocol which comprised of a form designed specifically to record information during the period of observation. For example, some cultural practices were observed during a funeral at Likpe-Kukurantumi, one of the study communities in the Upper Dayi Basin. The researcher observed the preparation of a special meal with indigenous brown rice which was a delicacy to the people. As part of the cultural practice the meal is served with soup to the elderly of the bereaved family.

3.5.8 Climatic Data

The closest meteorological station readings of both temperature and rainfall were used for the climatic analysis of the two basins. In Upper Afram basin, readings for Ejura Sekyedumasi were used whilst average figures for both Hohoe and Jasikan municipalities were used for Upper Dayi basin due to gabs in the data. Climatic data was obtained from the Ghana Meteorological Agency. Time-series analysis of rainfall and temperature trend from 1976 to 2016, showing seasonal variability and extreme events using INSTAT+ for Windows version 3.6 were conducted.

3.5.9 Satellite imagery and GIS Analysis

The closest municipalities to the study communities were used as reference to give a general view of the whole area, hence, Ejura Sekyedumasi and Hohoe municipalities were used as reference for the satellite imagery.

Raw Landsat satellite images that were cloud-free were downloaded from the U.S. Geological Survey's Earth Resources Observation and Science (USGS). Dry season images for the years 2000, 2010 and 2018 were captured. The acquired bands were then stacked to convert the image from panchromatic to multispectral image using Earth Resources Data Analysis System (ERDAS) Imagine 2014, image processing software. The next stage was the Classification of Images. Classification refers to the process of sorting pixels into a finite number of individual classes, or categories, of data based on their data file values. This could be done through Supervised or Unsupervised classification.

Unlike the supervised, unsupervised classification is more computer-automated. It allows one to specify parameters, example number of classes, that the computer uses as guidelines to uncover statistical patterns in the data. This approach was not adopted for this work, as the output after this classification is normally panchromatic (black and white) and there will be the need to add colours to the classified image before it can be used to compose a map. In the supervised classification, colours are assigned when generating the spectral signature. In this process, pixels that represent patterns that can be recognized or identified with help from other sources are selected. Knowledge of the data and the classes desired is required before selecting training samples. Image interpretation is very necessary to help achieve the above.

The computer system is designed to identify pixels with similar characteristics by identifying patterns in the imagery. The classification of pixels is supervised by setting priorities to these classes as they are assigned to a class value. The area of interest; that is the project area was used to subset the classified image using the ERDAS Imagine software. Recoding was then done by assigning a new class value number to all classes of the same spectral characteristics, and created

a new thematic raster layer using the new class numbers. This process also enabled the generation of the area per class. The attribute table obtained is then exported to excel and used to generate the statistics of the area. The final time series maps were composed using ArcMap software, and it showed the percentage of changes in the cover types from 2000, 2010 and 2018.

3.5.10 Data Analysis

The primary data collected during the study were analyzed both qualitatively and quantitatively. Qualitative data elicited from the interviews and focus group discussions were analysed after all the audio taped or recorded interviews were transcribed. The transcribed scripts were examined to identify themes. The themes were then interpreted and presented in descriptive forms.

Quantitative data obtained through the questionnaires were analysed using descriptive statistics and presented in the form of percentages, frequencies and tables. Climatic data comprising the rainfall and temperature trends collected over a specified period of years and Landsat satellite imagery of land use and land cover changes were also analysed.

3.5.11 Limitations of the study

A number of constraints were encountered during the study. Among these include gaps in the secondary data particularly the climatic data obtained from the Ghana Meteorological Agency. Some gaps were identified in the climatic data for the Upper Dayi basin. In addressing this challenge, the average climatic data of two closest meteorological stations, Hohoe and Jasikan were employed. Financial constraints also resulted in delay in the start of the field work as all attempts at attracting external funding for the study were not successful. An extension period

was therefore sought to help make up for the lost time. Another challenge encountered relates to the language barrier, particularly the translation of the questions from English to the local languages since the research was carried out in a multilingual setting. This was addressed by using interpreters from the communities.

3.5.12 Credibility and trustworthiness of study

While the researcher acknowledges the debate and lack of consensus on the issue of the validity of qualitative data collection and analysis, the nature of the research objectives suggests the use of a research approach and survey instruments that best capture information that can help describe and explain the phenomenon. Since the underlying motivation for the study was to understand the phenomenon of the erosion or marginalization of some local crop varieties, NUCS, the possible causative factors and the implications for household food security at local level, it was appropriate that the qualitative research method was employed for the study while quantitative data was used to augment information that the qualitative data could not capture.

Qualitative data is textual as compared to the numbers associated with quantitative method and therefore research rigours for the two methods are measured differently. While the rigour of the quantitative method is measured by validity and reliability, that of the qualitative data is ascertained through data trustworthiness which is achieved through the process of credibility, transferability, confirmability and dependability (McMillan & Schumacher, 2006; Moss, 2004; and Cohen, Manion & Morrison, 2007). Trustworthiness in this context refers to the extent to which one can trust or accept the study findings as true. Several measures were employed in this study to achieve data trustworthiness. Among these include:

- Credibility

Credibility was achieved by employing multiple data collection instruments and a number of data sources as a triangulation measure. These were intended to cross-check and guarantee the accuracy and consistency of the data collected. The use of different survey instruments such as individual interviews and multiple focus group discussions as well as other secondary data sources ensured that the responses elicited from the surveys were accurate.

- Confirmability

In achieving research objectivity, there was a verbatim transcription of all the audio recorded interviews. This ensured that the views of all respondents were captured. Field assistants were also engaged and adequately trained on the data gathering processes in order to ensure reliable data for analysis. Prior consent of respondents was sought in order to make sure the respondents were ready to participate voluntarily in the exercise. The purpose and objectives of the study were also clearly articulated and thoroughly discussed. This was to dispel all preconceived ideas, if any, so that the true and objective responses are elicited during the interviews.

- Dependability

In order to ensure dependability, the research instruments and data gathering processes were carefully selected and meticulously described to suit the research objectives and questions. For accuracy in the collected data and interpretation, records of all field documents including notes, observations and all other documents obtained from the field were cautiously maintained. From these documents the themes described were extracted.

CHAPTER FOUR

RESULTS

4.0 Introduction

This chapter presents the results of the socio-economic characteristics of the respondents interviewed during the study. An inventory of Neglected and Underutilized Crop Species, their uses and benefits as well as the possible effects of agricultural practices; environmental and socio-economic factors on neglected and underutilized crops cultivation in the Upper Afram and Upper Dayi basins have also been presented. The chapter finally presents experiences of households in relation to food security and NUCS in the study areas.

4.1 Socio-economic background of respondents

This section presents the analysis of the socio-economic characteristics of the respondents. This is important as it provides useful information to help understand the kind of respondents and how their unique backgrounds influenced their responses. In all, two hundred and seventy-one (271) respondents from the two study sites within the Upper Afram and Upper Dayi River basins were engaged during the study.

Demographic characteristics of respondents for the study covered the following areas: gender, age, marital status, educational status, ethnicity and origin.

4.1.1 Gender

The gender distribution of respondents in the two study areas are shown in Figures 4.1 and 4.2. The results generally revealed a higher percentage of male respondents (56%) compared to females (44%) for communities in the Upper Afram basin (Figure 4.1a). The gender distribution for the Upper Dayi basin recorded 65% male respondents and 35% females (Figure 4.2a). Female respondents however were found to be higher in communities such as Drobon (70%) in Upper Afram basin and Sanko Benua (55%) in Upper Dayi basin compared to their male counterparts in Figure 4.1b and 4.2b.

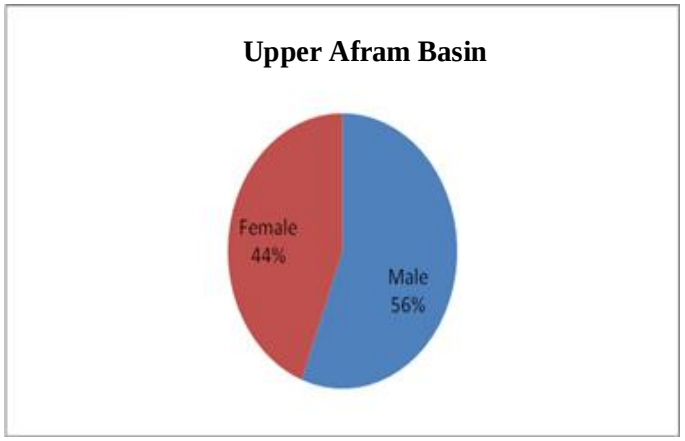


Figure 4.1a, Gender of respondent in **Upper Afram Basin**

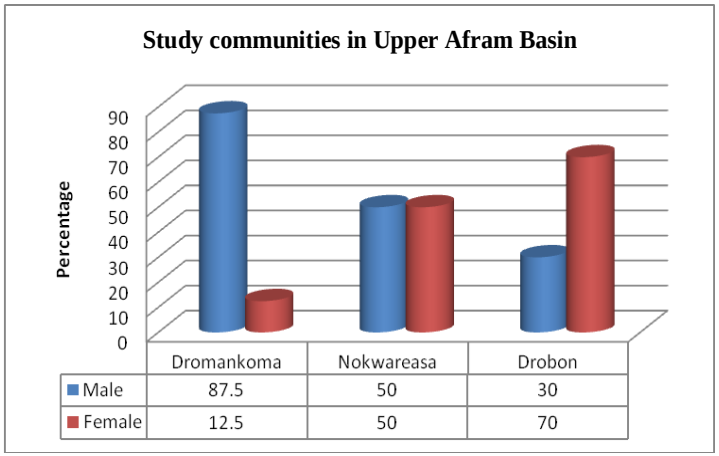


Figure 4.1b. Gender of respondent by community

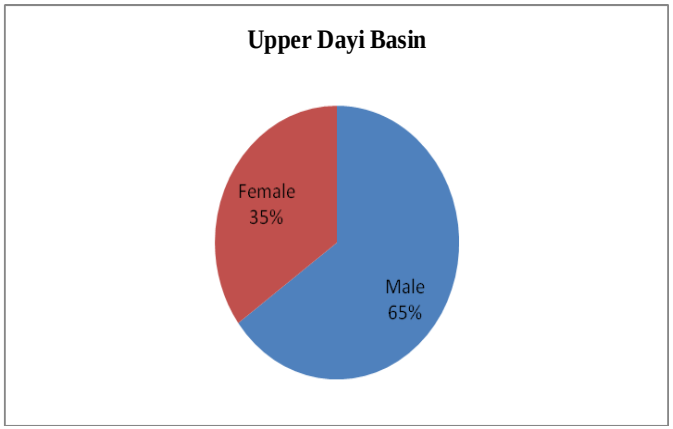


Figure 4.2a: Gender of respondent in Upper Dayi Basin

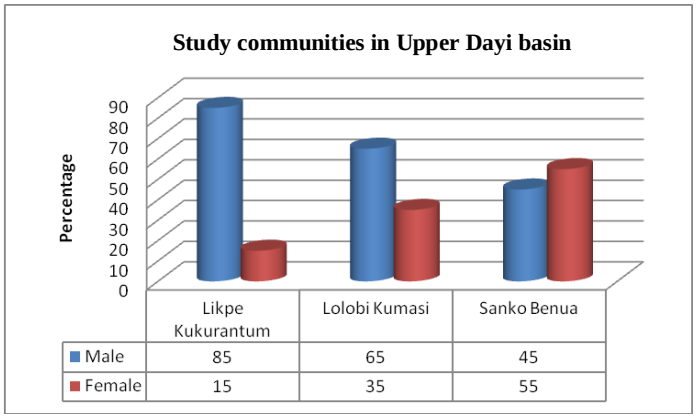


Figure 4.2b. Gender of respondent by community

4.1.2. Age

Analysis of the ages of respondents in the study areas are shown in Table 4.1. Respondents of the study were generally over forty (40) years of age. Over half of the respondents from both Upper Afram (55.8%) and Upper Dayi (60%) basins constituting the majority as shown in Table 4.1 were between the ages of 40 and 50. Upper Dayi basin however recorded a higher percentage of 16.7% of respondents above the age of sixty-one (61 years) compared to Upper Afram (10.8%).

4.1.3 Marital status

The marital status of the respondents is shown in Table 4.1. The results showed that majority of the respondents in both study areas were married. Over 60% of the respondents in both Upper Afram and Upper Dayi basins were married (Table 4.1).

4.1.4 Educational level

Results of respondent's educational status as shown in Table 4.1 indicate that 22.5% of respondents in the Upper Afram basin and 10% from Upper Dayi basin had no formal education. The rest of the respondents in both basins have had formal education ranging from primary to tertiary.

Table 4.1: Age, Marital Status and Educational Level of Respondents

	Upper Afram basin		**Upper Dayi basin**	
Age (Years)	**N**	**%**	**N**	**%**
40 – 50	67	55.8	72	60
51 – 60	40	33.3	28	23.3
61 >	13	10.8	20	16.7
Total	120	100	120	100

Marital Status	**N**	**%**	**N**	**%**
Never married	16	13.3	16	13.3
Married	82	68.3	76	63.3
Widow/Widower	19	15.8	20	16.7
Divorced	3	2.5	8	6.7
Total	120	100	120	100
Educational level	**N**	**%**	**N**	**%**
None	27	22.5	6	5
Primary	35	29.2	14	11.7
JHS/MSLC	26	21.7	52	43.3
SHS/O & A level	27	22.5	20	16.7
Vocational	0	0	18	15
Tertiary	5	4.2	10	8.3
Total	120	100	120	100

Majority of the respondents (29.2%) in Upper Afram basin had completed primary education while 43.3% constituting the majority of respondents in Upper Dayi basin completed secondary education (Table 4.1). Only 4.2% and 8.3% of the respondents in Upper Afram and Upper Dayi basins respectively had completed tertiary education.

4.1.5 Ethnicity

There was a wide disparity between communities of the two study sites with regard to ethnicity. Whereas the Upper Afram basin communities were highly heterogeneous both within and between communities, Upper Dayi basin communities were highly homogenous within the individual communities but highly heterogeneous between the communities. The wide variation

is attributed to the fact that communities of the Upper Dayi basin were selected from three different ethnic groups of the Guan tribe whereas communities of the Upper Afram basin comprised a mixture of the dominant Akan tribe and migrants.

Results shown in figure 4.3a indicate that respondents from the study communities of the Upper Afram basin were mainly Akans. Drobon (100%) recorded the highest number of respondents belonging to the Akan ethnic group, followed by Nokwareasa (62.5%) and Dromankuman (20%).

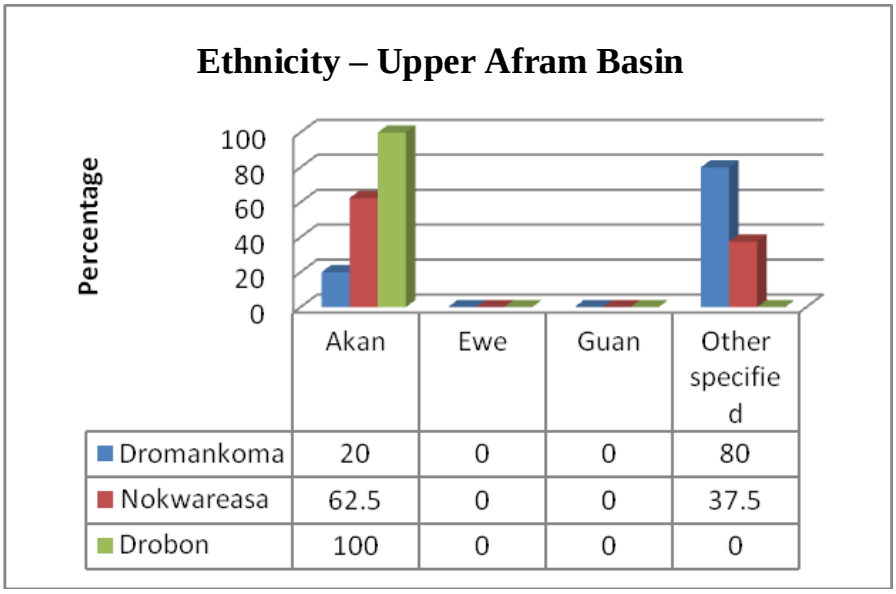


Figure 4.3a: Ethnicity of respondents in Upper Afram Basin

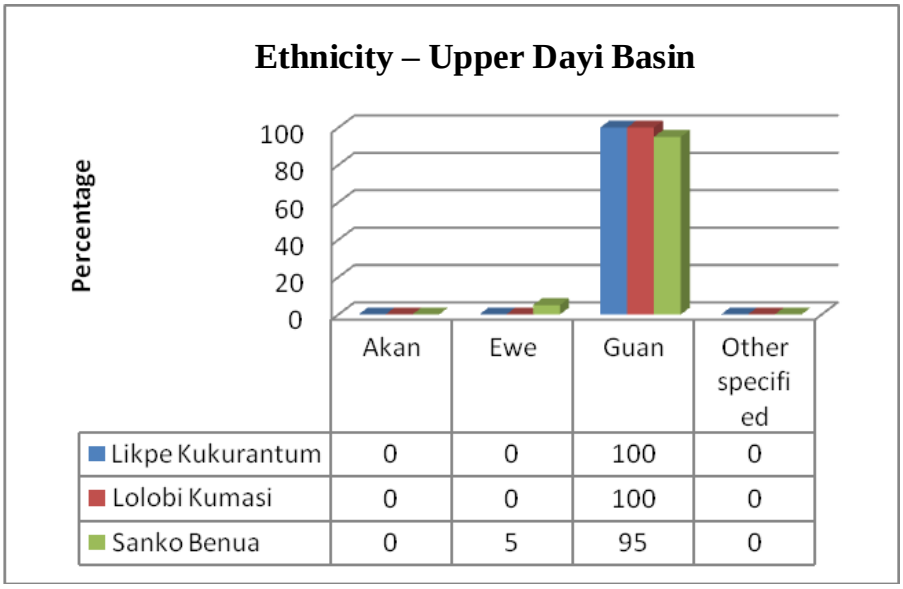


Figure 4.3b: Ethnicity of respondents in Upper Dayi Basin

Respondents from other ethnic groups including the northern groups were also recorded even though they were relatively smaller, in Dromankuman and Nokwareasa (Figure 4.3a). In the Upper Dayi basin, respondents from Likpe Kukurantumi, Lolobi Kumasi, and Santrokofi Benua were all of Guans origin (Figure 4.3b) but with linguistic and ethnic differences. Thus, in terms of spoken language, all the respondents from Likpe spoke *Sekpele*, those from Lolobi spoke *Lelemi* while those from Santrokofi spoke *Sele*.

4.1.6 Origin

Responses on the origin of the respondents of the two study areas are presented in Figures 4.4a and 4.4b. The results from Upper Afram basin, showed that (95%) of the respondents from Drobon were indigenes. This is a typical Akan community who were mainly peasant farmers. Respondents from Dromankuman on the other hand were mainly settlers from the northern parts of Ghana as shown in Figure 4.4a.

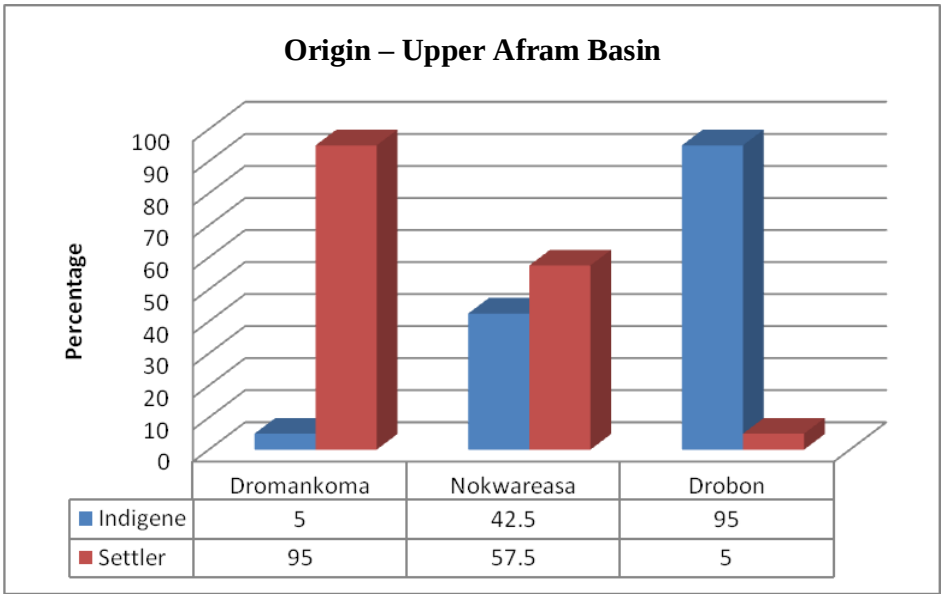


Figure 4.4a: Origin of respondents in Upper Afram Basin

Nokwareasa which is a mixed community recorded 42.5% of indigenes and 57.5% settlers. Respondents from Upper Dayi study communities were mainly indigenes. With the exception of Santrokofi-Benua which recorded 5% of respondents who were settlers, respondents from all the communities including Likpe-Kukurantumi and Lolobi-Kumasi were natives (Figure 4.4b).

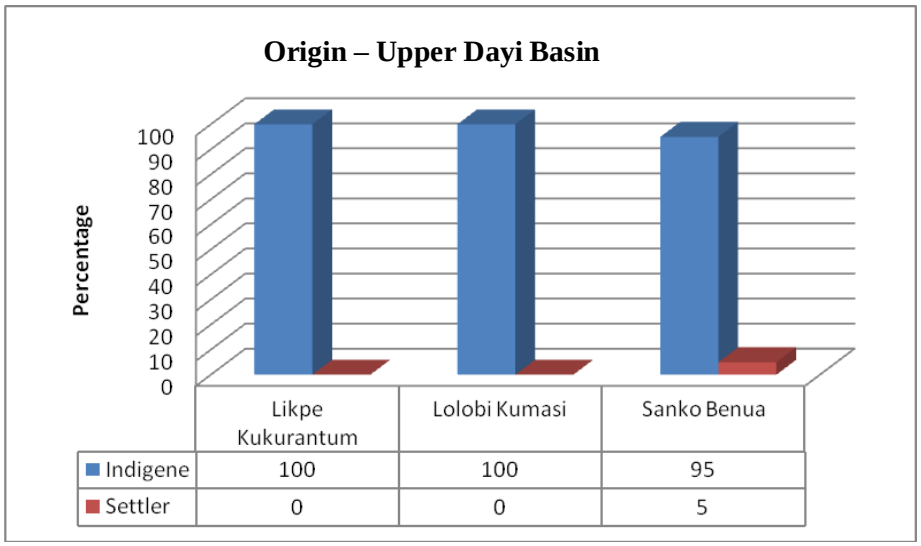


Figure 4.4b: Origin of respondents in Upper Dayi Basin

4.2 Crop Inventory

This section provides the results of the survey of the crop varieties and NUCS; their uses and benefits in the study areas. It presents the crop varieties currently cultivated and then provides a profile of the NUCS that are currently marginalized or no longer cultivated and their uses in the study basins

4.2.1 Crop varieties in the Upper Afram basin

A survey of the crop varieties currently grown in the study communities in the Upper Afram basin are presented in Tables 4.2a & 4.2b. The crops include cereals namely rice and maize; legumes namely cowpeas, beans and groundnuts; vegetables such as okra, garden eggs, pepper, tomatoes; root and tubers notably cassava, varieties of yam, and plantain. Tree crops include cashew, oil palm, and mango, among others.

4.2.2 Crop varieties in the Upper Dayi basin

Responses elicited from the local farmers on the food crop varieties currently cultivated in the Upper Dayi basin are shown in Tables 4.3a & 4.3b. The crops include maize, rice (cereal); cowpea, *agushi*, groundnut (on low scale) (legumes); okra, pepper, tomatoes, ginger, cherry tomatoes (vegetables); cassava, cocoyam, yam (roots and tubers); cocoa, plantain, banana, pineapple, and oil palm (tree crops and fruits).

Table 4.2a: Inventory of crop varieties and NUCS in Upper Afram Basin

Basin	Crop varieties	NUCS
Upper Afram	**Cereals** Maize (*Zea mays*), Rice (*Oryza spp.*)	**Cereals** Maize sp. (*Zea mays*)- Dwarf, Obaatanpa, Abrohama (long cob with lots of smaller grains), Dobidi (white), Daduanan (yellow), Laposta, Mamaba (white), Okomasa (white), Abelehi (white), Debo Millet (*Pennisetum glaucum*), Sorghum (*Sorghum bicolor*), Ekpe (kokomba language), Mokoko
	Legumes Cowpea (*Vigna unguiculata*), Groundnuts (*Arachis hypogea*)	**Legumes** Bambara beans (*Vigna subterranea*), Agushi (*Citrullus colocynthis*), Werewere (*Citrullus vulgaris*), Beans – [varieties: Atidua (red beans – *Vigna* sp.), Apatram (white; *Phaseolus vulgaris*), Akye, Aduakuma (coloured; *Phaseolus sp*.), Aduapia (Phaseolus sp.), Adua daagati (*Vigna sp.*), Pangabu (*Vigna sp.*) Forehead (*Vigna sp., whitish)*, Osei (*Vigna sp., spotted)*], red groundnut (*Arachis hypogea*).
	Vegetables Okro (*Abelmoschus esculentus*), Garden eggs *(Solanum incanum)*, Pepper (*Capsicum annuum*), Tomatoes (scale has come down drastically, *Lycopersicon esculentum*)	**Vegetables** Efra (pumpkin, *Cucurbita maxima*), Misewa (pepper, *Capsicum anmum*), Monsurowa (type of garden eggs, *Solanum sp.*), Kwahu nsusua (turkey berry, *Solanum torvum*), Cucumber (*Cucumis sativus*)
	Root & tubers Cassava, Yam sp. (*Dioscorea sp.*) – Lele (Kaseibayere), Laribakor, Puna	**Root & tubers** Nkanfoɔ (*Dioscorea dumetorum*), Cocoyam (*Xanthosoma spp*), Taro (*Colocasia esculenta*), Sweet potato (*Ipomoea batatas*), Yam species: [Bayere Kwankwesi, Asobayere (hard with sweet taste), Ahabayere, Apoka (big roundish), Anomesu, Nsuabayere, Densi (Esum ne Hyen), Nananto (good taste and flavour), Akaba, Krokropa (small and roundish), Latopa (hairy), Bole, Tampi, Kyikumasi, Atipe (yellowish), Ahonome (high yielding, smallish with sweet taste), Akam (Aerial Yam), Edunkra, Afase Kokoo, Natori, Nemoɔ (strong good flavour), Saabri, Nkuku (roundish), Afasiemansa (water yam), Daatori, Anasu (yellowish water yam), Tantanpruga, Nankani

		(round, sweet taste)
	Tree crops/Plantation/Fruits Plantain (*Musa paradisiaca*), Cashew, Oil Palm (*Elaeis guineensis*), Watermelon (*Citrullus lanatus*)	**Tree crops/ Plantation/Fruits** Cocoa (*Theobroma cocao*), Pear (*Pyrus spp.*), Alatakwadu (*Musa spp.*), Asantekwadu (*Musa spp.*), Pineapple (*Ananas comosus*), Sugarcane (*Saccharum officinarum*), Afrɛ (Types of Apple, *Malus spp*), Water Melon (*Citrullus lanatus*), Salo Mango (*Mangifera spp.*), Dawadawa (*Parkia biglobosa*), Guava (*Psidium guajava*), Atia (cashew, *Anacardium occidentale*), Asua (Miracle Fruit, *Synsepalum dulcificum*), Pawpaw (*Carica papaya*), Oniaba (Type of Plantain, *Musa spp.*), Medom (Type of Oil Palm, *Elaeis spp.*)

Table 4.2b: Inventory of crop varieties and NUCS in study communities in Upper Afram Basin

Community	Crop varieties	NUCS
1. Nokwareasa	**Cereals** Maize, rice	**Cereals** Millet, Sorghum, *Ekpe*, Maize sp.- *Abrohowa* *Dobidi* *Mamaba* *Okomasa* *Daduanan*
	Legumes Cowpea, groundnuts	**Legumes** Beans- *Apatram, Aduakama, Aduapia, Aduadaagati* Bambara Beans, Red beans, Pangabu, *Agushi*, *Werewere*
	Vegetables Okro, Pepper, Garden eggs, Tomatoes	**Vegetables** *Efra* (pumpkin), *Nonsurowa* (garden eggs), *Kwahu nsusua*, Cucumber
	Root & Tubers Yam Cassava	**Root & Tubers** *Nkanfo*, Yam- *Ahonume, Akam* (aerial yam), *Enumasu, Ahabayere, Edunkran, Apoka, Densi (Esum ne shen), Nanto/Nananto, Akaba, Afase Kokoo, Lele (Kaseibayere), Natori, Atipe, Nemo, Saabri Nkuku, Afasie mansa, Daatori, Anansu, Tantan Pruga* Sweet potato Taro Cocoyam
	Trees/Plantation/Fruits Plantain, cashew, Palm nuts	**Trees/Plantation/Fruits** Sugarcane, banana, pineapple, *Afre* (type of apple), watermelon, Salo mango, *Dawadawa*

		Fruit – Guava, *Atia, Asua* (miracle fruit), Pawpaw, *Oniaba* (Plantain)
2. Dromankoman	**Cereals** Maize, rice	**Cereals** Maize
	Legumes Cowpea, groundnut Vegetables Garden eggs, Pepper, Okro	**Legumes** Beans (forehead-white) Vegetables *Misewa* (pepper), Tomatoes (scale has come down drastically)
	Root &Tubers Yam-Lele (Kaseibayere), Laribakor, Puna, Dudumpura Cassava	**Root & Tubers** Yam - *Akaba, Nanto, Anumasu*, (water Yam), *Krokropa*-round, *smallish*, *Latopa*-hiry, *Bole, Tampi, Kyikumasi, Atipe, Nkanfo*
	Trees/plantation/fruits Water melon	**Trees/plantation/fruits** Pawpaw
3. Drobon	**Cereals** Maize, rice	**Cereals** Maize, *Laposta, Dwarf, Baatampa, Abrohama, Debo Mokoko*, some maize sp.
	Legumes Cowpea, Grondnut	**Legumes** *Apatram*, Beans-*Akye*, Bambara beans, *Atidua* (red beans)
	Vegetables Garden eggs, okro, pepper	**Vegetables** *Misewa* (pepper), *Yaa Asantewaa*, *Nsusua*, Pumpkin
	Root &Tubers Yam	**Root & Tubers** Cocoyam, *nakanfo* Yam-*Bayere kwankwesi, Asobayere, Ahabayere, Apoka, Anomasu, Nsuabayere, Esum ne hyen (densi), Nananto*

Table 4.3a: Inventory of crop varieties and NUCS in Upper Dayi Basin

Basin	Crop varieties	NUCS
Upper Dayi Basin	**Cereals** Maize (*Zea mays*) Rice (*Oryza spp.*)	**Cereals** Indigenous brown rice (*Oryza glaberrima)* Rice sp. *Twomavor*, *Mawulukp*u *Akuablue, Kable, Khaki, Akpese, Mawutse, Tomayobi*
	Legumes Cowpea (*Vigna unguiculata*), *Agushi*, Groundnut (on low scale, *Arachis hypogea*)	**Legumes** Bambara Beans (*Vigna subterranea*), *Apatram* (*Phaseolus sp*.), *Akani, Kakpe, Agushi* (*Citrullus colocynthis*)
	Vegetables Okro (*Abelmuoschus esculentus*), Pepper (*Capsicum annuum*), Tomatoes	**Vegetables** Shallots (*Alium spp.)*, Misewa (pepper, *Capsicum anmum*), Soro wisa (African Black pepper), Bitter leaves (*Vernonia amygdalina*), *Akpamkpele* (small

	(Lycopersicon esculentum), Ginger (*Zingiber officinale)*, Cherry tomatoes (*Lycopersicon sp.*)	garden eggs, *Solanum spp.*)
	Root &Tubers Cassava (*Manihot esculenta*), cocoyam (*Xanthosoma spp*), yam (*Dioscorea sp*.)	**Root & Tubers** *Nkanfo* (*Dioscorea dumetorom*), Sweet Potatoes (*Ipomoea batatas*), Taro (*Colocasia esculenta*), Yam varieties: *Nakani, Oboaduanan, Befosi, Seklorsi, Aerial yam, Kookoasi bayere, Snake water yam*
	Trees/Plantation/ Fruits Cocoa (*Theobroma cocao)*, plantain *(Musa spp.)*, banana *(Musa paradisiaca)*, Pineapple *(Ananas comosus)*, oil palm *(Elaeis guineensis)*	**Trees/Plantation/ Fruits** Cashew *(Anacardium occidentale)*, coffee (*Coffea sp.*), *Bebitoklotsa* (infant banana), *Boaborfi* (purplish banana)

Table 4.3b: Inventory of crop varieties and NUCS in study communities in Upper Dayi Basin

Community	Crop varieties	NUCS
1. Likpe	**Cereals** Maize, rice	**Cereals** Rice – indigenous brown rice- e.g.: *Kamortintin, Mawulukpu, Tomayobi, Mawetse, Akpese, Akuablue*
	Legumes Beans (red & white)	**Legumes** *Agushi*, Groundnut, Beans- (*aketekubi*)
	Vegetables Okra, Pepper, Tomatoes, Ginger, Garden Eggs, Groundnut	**Vegetables** Shallots, *Misewa* (Pepper), *Sorowisa* (African black pepper)
	Root & Tubers Cassava, cocoyam, yam	**Root & Tubers** Yam-*Befosi*, *Seklorsi*, Aerial yam, *Krokosi Bayere*, Snake water yam, *Nkanfo* Sweet Potato
	Trees & Plantain/fruits Cocoa, Plantain, banana	**Trees & Plantain/fruits** *Bebito klotsa* (infant banana) *Boaborfi* (purplish banana)
2. Lolobi	**Cereals** Rice, Maize	**Cereals** Indigenous brown rice: *Boadekamor*
	Legumes Groundnuts (on low scale), cowpea	**Legumes** *Kakpe* (beans)
	Vegetables Okra, Pepper, Garden eggs	**Vegetables** Bitter Leaves, Shallots
	Root & Tubers Yam	**Root & Tubers** *Kookoasebayere*

	Trees & Plantation/Fruits Plantain, Cocoa	**Trees & Plantation/ Fruits** Coffee
3. Santrokofie	**Cereals** Maize, rice	**Cereals** Indigenous brown rice- *Balegamo* Rice Sp.-*Twomavor* *Akuablue* *Kablɛ* *Khaki* *Akpese*
	Legumes Groundnuts, Cowpea, Agushi	**Legumes** Bambara beans, *Apatram, Aketeku, Akani*
	Vegetables Pepper, Okro, Garden eggs, tomatoes, Cherry tomatoes	**Vegetables** *Akpamkpele* (small garden eggs)
	Root &Tubers Cassava, Cocoyam	**Root & tubers** Potatoes, Taro, Yam-*obaduanan* *Nkani*
	Trees/Plantation/ Fruits Plantain, cocoa, Pineapple, Banana, Palm fruit	**Trees/Plantation/Fruits** Cashew

4.2.3. NUCS in the Upper Afram Basin

Interactions with the farmers in the study communities showed that some indigenous food crop varieties that were cultivated some years ago are currently either marginalised or no longer cultivated. A total of eighty (80) NUCS were identified during the survey at Upper Afram basin (Table 4.4). Of the 80 NUCS identified, 14 were cereals, 13 were legumes, 5 were vegetables, 32 were root and tubers, and 16 were tree crops and fruits. Of the 32 root and tubers identified, over twenty (20) yam varieties were recorded. Several yam varieties in the study area are therefore currently marginalized.

Several varieties of yam (root and tubers) and other tree crops that were previously cultivated but no more cultivated in the study communities in Upper Afram basin were also identified (Table 4.2a).

Table 4.4: Comparison of the crop varieties currently cultivated and the NUCS

Food crop category	Upper Afram Basin		Upper Dayi Basin	
	Crops cultivated	**NUCS**	**Crops cultivated**	**NUCS**
Cereals	2	14	2	8
Legumes	2	13	3	5
Vegetables	4	15	5	5
Root & Tubers	4	32	3	10
Trees/Plantation/Fruits	4	16	5	4
Total	**16**	**80**	**18**	**32**

The yam varieties that were identified include: *Bayere Kwankwesi, Asobayere* (hard with sweet taste), *Ahabayere, Apoka* (big roundish), *Anomesu*, *Nsuabayere*, *Densi (Esum ne Hyen)*, *Nananto* (good taste and flavour), *Akaba, Krokropa* (small and roundish), *Latopa* (hairy), *Bole, Tampi, Kyikumasi, Atipe* (yellowish), *Ahonome* (high yielding, smallish with sweet taste), *Akam* (Aerial Yam), *Edunkra, Afase Kokoo, Natori, Nemoɔ* (strong good flavour), *Saabri*, *Nkuku* (roundish), *Afasiemansa* (water yam), *Daatori*, *Anasu* (yellowish water yam), *Tantanpruga*, *Nankani* (round, sweet taste). Among the different tree crop varieties identified are Cocoa (*Theobroma cocao*), Pear (*Pyrus spp.*), *Alatakwadu* (*Musa spp.*), *Asantekwadu* (*Musa spp.*), Pineapple (*Ananas comosus*), Sugarcane (*Saccharum officinarum*), *Afrɛ* (Types of Apple, *Malus spp.*), Water Melon (*Citrullus lanatus*), Salo Mango (*Mangifera spp.*), *Dawadawa* (*Parkia biglobosa*), Guava (*Psidium guajava*), *Atia* (cashew, *Anacardium occidentale*), *Asua* (Miracle Fruit, *Synsepalum*

dulcificum), Pawpaw (*Carica papaya*), *Oniaba* (Type of Plantain, *Musa spp.*), Medom (Type of Oil Palm, *Elaeis spp.*).

4.2.4 NUCS in the Upper Dayi Basin

Results of the survey of local food crops that are no longer cultivated or currently underutilized in the study communities are presented in Table 4.3b. The NUCS have been grouped and listed under the following categorization: cereals; legumes; vegetables; roots and tubers; trees; plantain and fruits. Thirty-two (32) NUCS were identified during the survey in the study communities (Table 4.4). Out of the 32 NUCS identified, there were 8 cereals, 5 legumes, 5 vegetables, 10 root and tubers, and 4 tree crops and plantations. The root and tubers recorded the highest number of marginalized crop species. These include *Nkanfo* (*Dioscorea dumetorom*), Sweet Potatoes (*Ipomoea batatas*), Taro (*Colocasia esculenta*), Yam varieties: *Nakani, Oboaduanan, Befosi, Seklorsi,* Aerial yam, *Kookoasi bayere,* Snake water yam. This was followed by cereals: Indigenous brown rice (*Oryza glaberrima)* Rice sp. *Twomavor, Mawulukpu Akuablue, Kable, Khaki, Akpese, Mawutse, Tomayobi*. Rice was found to be the commonly grown food crop among farmers in the study communities. The indigenous brown rice (*Oryza glaberrima)* which was a delicacy is currently marginalized and grown on a minimal scale. Pictures of some selected NUCS are presented in Plates 4.1 to 4.6.

[A] Cereal

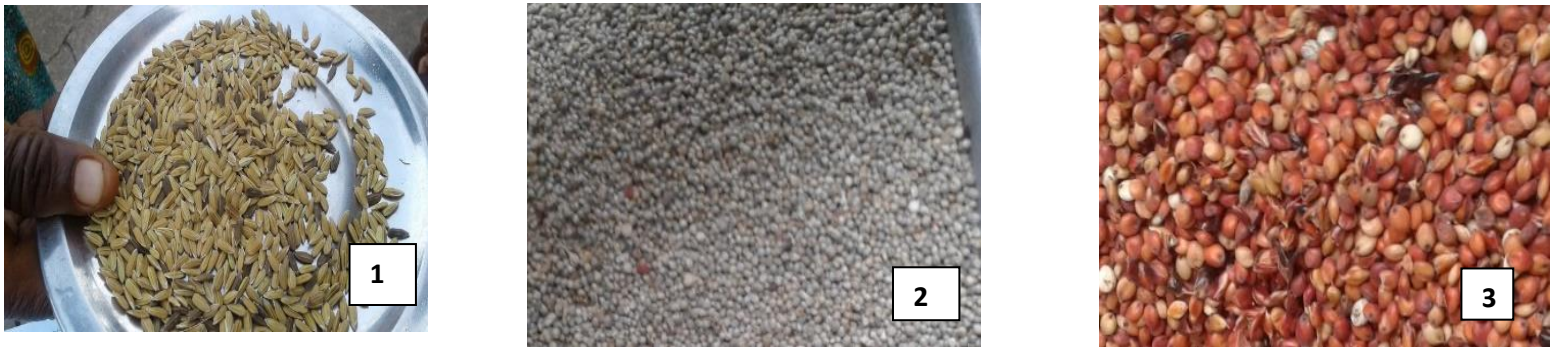


Plate 4.1: Pictures of some selected NUCS (cereals): [A1] Indigenous brown rice [A2] Millet [A3] Sorghum

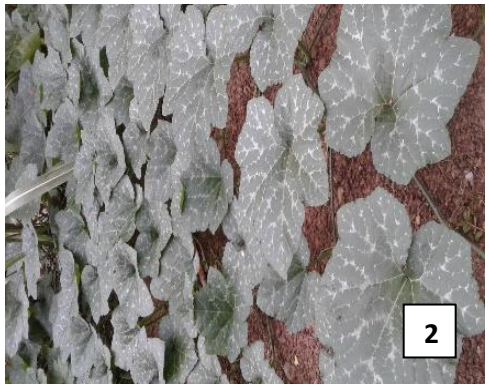
[B] Legumes

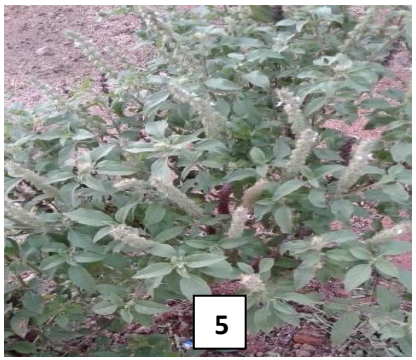
Plate 4.2: Pictures of some selected NUCS (legumes): [B1] Soyabean [B2] Red beans [B3] *Werewere* [B4] Kidney bean [B5] *Apatram* (*Phaseolus vulgaris*) [B6] White *apatram* (*Phaseolus sp.*)

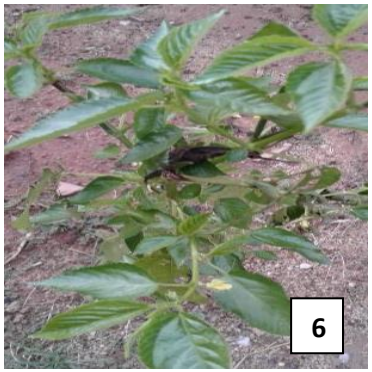
[C] Vegetables

Plate 4.3: Pictures of some selected NUCS (vegetables): [C1] *Nsusua* [C2] Garden eggs- *ntropo* [C3] Shallots [C4] Chili pepper [C5] *Nsusua*

[D] Leafy vegetables







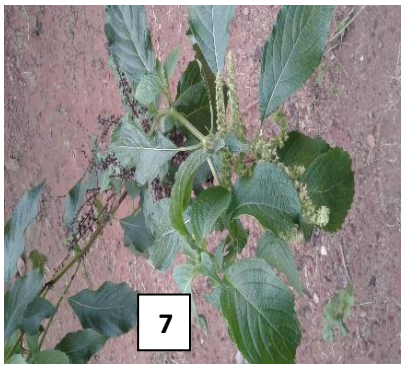


Plate 4.4: Pictures of some selected NUCS (leafy vegetables.): [D1] *Borkorborkor* [D2] Pumpkin leaves [D3] *Solanum Sp.* (*atropo*) [D4] *Akokobesa* [D5] *Mme* [D6] *Ayoyo* [D7] *Nunum*

[E] Roots and Tubers

Plate 4.5: Pictures of some selected NUCS (roots and tubers): [E1] *Atretre* (water yam) [E2] *Nkanfo* [E3] Aerial yam [E4] *Densi* [E5]*Colocasia esculentum* (Taro- Brobe) [E6] *Akaba* [E7] *Atipe* [E8] *Akaba tenten*

[F] Trees/plantation/fruits

Plate 4.6: Pictures of some selected NUCS (trees/plantation/fruits): [F1] Mango [F2] Miracle berry [F3] Tamarind [F4] Plantain [F5] Banana [6] *Asanfron*

4.2.5 Uses and benefits of NUCS

Responses elicited from farmers from interviews in the Upper Afram and Upper Dayi basins generally revealed that the currently marginalized local food crop varieties provided several benefits and uses and played important roles in traditional ceremonies, feed for livestock, dyes, fodder, medicinal, fuel wood, nutritional, food, soap among others (Table 4.5). Regarding the method of preparation and the parts of the crop or plant (NUCS) used, the farmers in both study areas pointed out various methods including boiling, roasting and frying. According to them the commonly used parts include the seeds, leaves, stalk, fruits, roots and tubers. On the consumption pattern and preference for the marginalized crop varieties among different age groups it was found that consumption was high (98%) among both males and females even though it was also indicated that the preference and consumption of some of these indigenous crops among current younger generation is generally low perhaps due to the lack of knowledge of these crops and their nutritional benefits.

4.2.5.1 Uses and benefits of NUCS in the Upper Afram Basin

The marginalized local food crop varieties according to the farmers generally served as source of food with the surplus of their produce being sold for some income. The farmers during the focus group discussions provided examples of typical indigenous food crops that are currently marginalized but played important roles in sustaining their families. For example, *Akyɛ*, a brownish coloured bean (*Vigna spp*.), was known for its nutritious and pleasant taste as well as its ability to sustain and satisfy one's hunger for a long period. A farmer at *Drobon said "Akyɛ, it will stay on you for long time when you eat and it is heavy".* The leaves of some bean species were also used for soup preparation and the liquid obtained from cooking the leaves used for

medicinal purposes. *Phaseolus spp*. (lima beans or locally called '*Apatram*') for example was used mainly for soup preparation. This was patronized by pregnant women mainly due to their belief in its ability to facilitate easy labour or delivery. Pawpaw leaves and pineapple (fruit and peels) and at times in combination with other herbs were used for medicinal purposes; especially in eliminating or curing feverish conditions. Pumpkin locally referred to as *Efre* was also considered to possess some medicinal properties.

Millet was also found to have several uses. Millet grains, apart from being used for porridge, a breakfast meal and other meal preparation, were also used in the preparation of an alcoholic drink called '*pito*'. As one farmer from Dromankoman puts it, "*Millet gives difference to our food".* The millet stalk also served as feed for their livestock; source of cook fuel and was also used for traditional mat weaving. Yams traditionally also served as a major item in gift packages for respected people in the communities. *Kwahu nsusuaa* and *Monsorowa* (also called *nsusuaa*), apart from being very nutritious also served as a remedy for managing cases of anaemia.

4.2.5.2 Uses and benefits of NUCS in the Upper Dayi Basin

The NUCS identified were found to provide several benefits to inhabitants of the study area. These crops served mainly as food items and the excesses sold to earn some income. Indigenous brown rice, referred to as '*Kamortintin*' was found to be a delicacy even though it was marginalized. A respondent at Likpe, said *"Kamortintin is good, is sweet, it begins to be big and swell when you cook, it takes water, then it becomes plenty".* According to the farmers, the water that remains after rice has boiled for some time is scooped and used as a form of Orally Rehydrated Salt (ORS) for the sick. Indigenous brown rice is also presumed to be good for diabetes. A common feature among all the three study communities within this river basin is the

use of the indigenous brown rice in the performance of some cultural practices especially in funerals and marriage ceremonies; and other activities including outdooring and installation of chiefs.

In Lolobi, this indigenous brown rice is roasted, milled and prepared into a local delicacy called *Kamorkra* (Plate 4.1). This is also called *kpakusi* at Likpe. This traditional delicacy is usually expected to be prepared by the groom and sent to his in-laws. This meal is served with a special stew prepared with *Kakpe* (local climbing beans). Bitter leaves, locally called *Segbe* in Lolobi, is an NUCS that has several medicinal uses. *Nsusua* (*Solanum* spp.), *misewa* (pepper), *esorowisa* (African black pepper) and ginger are also believed to possess both nutritional and medicinal properties that help to manage some health conditions such as fever and stomach upsets. Other marginalized fruits mentioned and also deemed important by the farmers included some species of banana, known as '*Oklocha*' and '*Kokote*'. In Likpe '*Oklocha*' was processed into a porridge-like food after boiling and mashed with a local sponge for smoothness, in a calabash. This was used to feed infants and babies and this made them grow very healthily. The people of Santrokofie also fed their babies on local bananas for their nutritional and health benefits. The '*Oklocha*' banana species is also believed to contain some medicinal properties that help people suffering from piles. Another banana species, '*Kokote*' (Likpe), which is violet in colour was used in place of plantain in 'fufu' preparation; and also, a traditional delicacy called '*akankye*'.

Plate 4.1: Typical processing and use of *Oryza glaberrima* indigenous brown rice currently marginalized at Likpe and Lolobi

Scientific name	Common name	*Local name*	Life form	Part(s) used	Purpose	Method of preparation
A. Cereals						
1. Zea mays	Maize	*Abro*	Grass	Seeds/leaves	Food/fodder/ feed livestock	Boiling/roasting
2. Pennisetum glaucum	Millet	*Ayuo*	Grass	Seed/leaves & stalk	Food/drink/mat/ feed livestock/ basket	Boiling/roasting
3. Sorghum bicolour	Sorghum		Grass	Seed/leaves & stalk	Food/fuelwood/feed livestock/dye	Boiling/roasting
4. Oryza glaberrima	Ind. Brown rice	*Kamor*	Grass	Seed	Food/traditional ceremonies	Boiling/roasting
B. Legumes						
1. Vigna subterranean	Bambara beans	*Akyin*	Herb	Seeds	Food	Boiling/roasting
2. Citrullus colocynthis	Egushi/Agushi	*Egushi*	Climber	Seeds	food/ stew/ sauce	stewing
3. Citrullus vulgaris	Werewere/ neri	*Werewere*	Climber	Seeds	food/soup	boiling/roasting
4. Vigna unguiculata	Red beans	*Atidua*	Herb	seeds/leaves	food/stew	boiling
5. Phaseolus vulgaris	Limma	*Apatram*	Climber	Seeds	food/soup	boiling
6. Vigna spp.	Brown beans	*Akyɛ*	Herb	Seeds	Food	boiling
7. Arachis hypogeal	Groundnut (red)	*katekokoo*	Herb	Seeds	Food	boiling/roasting/frying
C. Vegetables						
1. Cucurbita maxima	Pumpkin	*Efrɛ*	Climber/Vine	fruit/seeds/leaves	food/medicinal	raw/boiling/stewing
2. Capsicum anmum	Small Pepper	*Misewa*	Shrub	Fruit	food/nutritional/medicinal	raw/boiling
3. Solanum sp.	Small garden eggs	*Monsurowa/ nsusuaa*	Shrub	Fruit	food/nutritional/medicinal	Boiling
4. Cucumis sativus	Cucumber		Climber/Vine	Fruit	food/nutritional	raw/boiling
5. Solanum torvum	Turkey berry	*Kwahu nsusua*	Shrub	fruit & leaves	food/ nutritional/medicinal	raw/boiling
D. Roots and tubers						
1. Dioscorea dumetorum	Yam sp.	*Nkanfoɔ*	Climber/Vine	Roots/tubers	Food	Boiled with skin on
2. Xanthosoma spp.	Cocoyam	*Mankani*	Herb	Roots/tubers/leaves	food/ feed poutry/ stew/soup	Boiling/roasting/frying
3. Colocasia esculenta	Taro	*Brobe*	Herb	Roots/tubers/leaves	food/ stew/ feed poultry	Boiling/roasting/frying

4. Ipomoea batatas	Sweet potato	*Ntromo*	Climber/Vine	Roots/tubers/leaves	food/feed livestock	Boiling/ roasting/frying
5. Dioscorea sp	Yam species	*Bayere*	Climber/Vine	Roots/tubers	Food	Boiling/roasting/frying
E. Tree crops/ Plantations						
1. Theobroma cocao	Cocoa	*Cocoa*	Tree	Fruit/seed	Food	Raw/ Industrial processed
2. Persea spp.	Pear	*Paya*	Tree	Fruit	Food	Raw
3. Musa spp.	Banana	*Alatakwadu*	Shrub	Fruit	Food	Raw
4. Musa spp.	Local Banana	*Asantekwadu*	Shrub	Fruit	Food	Raw/boiled in some cases
5. *Ananas comosus*	Pineapple	*Abrobe*	Shrub	Fruit/fruit peels	food/medicinal	Raw/peels boiled
6. Saccharum officinarum	Sugarcane	*Ahwedeɛ*	Tree	Fruit	food/medicinal	Raw/Ind. Processed
7. Malus spp.	Type of apple	*Afrɛ*	Shrub	Fruit	Food	Raw
8. *Mangifera indica*	Salo mango	*Gyapha*	Tree	fruit/bark/leaves	food/medicinal	Raw/ bark & leaves boiled
9. Citrullus lanatus	Water melon		Vine/Climber	Fruit	food/nutritional	Raw
10. Parkia biglobosa	Dawadawa	*Dawadawa*	Tree	fruit/seed	food/nutritional/medicinal	raw/seeds cooked
11. Psidium guajava	Guava	*Agewa*	Tree	fruit/leaves	food/medicinal	Raw
12. Anacardium occidentale	Cashew	*Atia*	Tree	fruit/seed	food/snack	Raw/roasted
13. Synsepalum dulcificum	Miracle fruit	*Asua*	Shrub	Fruit	Food	Raw
14. Carica papaya	Pawpaw	*Brofrɛ*	Shrub	fruit/leaves	food/medicinal	Raw/ leaves boiled
15. Musa paradisiacal	Type of plantain	*Oniaba*	Shrub	Fruit	Food	Boiling/ frying/roasting
16. Elaeis guineensis	Type of oil palm	*Medom*	Tree	Fruit	food/oil/soap	Boiling

Table 4.5: Profile of some NUCS

Table 4.6: Nutrient composition per 100g Fresh edible portion of selected traditional vegetables compared with exotic vegetables

	Amaranthus sp. **(Aleefu)**	***Corchorus olitorius*** **(Ademe)**	**Cocoyam leaves**	***Solanum torvum***	**Lettuce**	**Cabbage**
Carbohydrate (g)	12.13	19.56	15.63	7.50	2.79	5.8
Energy (kcal)	49.89	56.78	38.48	43.7	15	25
Fibre (g)	1.78	1.61	3.34	5.40	1.3	2.5
Protein (g)	9.41	5.42	11.61	2.20	1.36	1.3
Fat (g)	0.35	0.43	0.71	0.76	0.15	0.1
Vit C (mg)	3.86	14.56	2.58	112.60	9.2	36.6
Vit A (IU)	2149	3214	3116	4172	7405	98
Iron (mg)	45.41	19.53	15.92	10.6	0.86	0.47
Calcium (mg)	252.1	276.4	196	59	36	40
Phosphorus (mg)	81.55	66.68	79.22	67.39	29	26
Potassium (mg)	348.18	481.15	285.66	399.73	194	170

Source: Nyadanu and Lower (2014)

Table 4.6 gives the nutritional composition of selected traditional and exotic vegetables from Nyadanu and Lower's studies. Other studies from researchers such as Muhammad (2014) and Padulosi *et al*. (2013) have emphasized the nutritional composition of many leguminous crops which are known to contain high levels of protein and minerals. In the present study some varieties of leguminous crops (such as Bambara beans (*Vigna subterranea*), *Agushi* (*Citrullus colocynthis*) and *Phaseolus sp*.) which also contain these important nutrients were also found to be marginalised.

4.2.6. Reasons for marginalization of some local food crop varieties in the study areas

The factors underlying the current marginalization of some local food crop varieties in Upper Afram and Upper Dayi basins are presented in Table 4.7. The three major reasons presented by farmers in both river basins were labour-intensive and time-consuming methods of cultivation; low productivity; and limited water resources. The first three reasons adduced by the farmers in Upper Dayi basin happen to be the same as those mentioned by the respondents at Upper Afram basin with higher percentages at Upper Dayi basin. Sixty percent (60%) of the farmers in Upper Dayi basin as compared to thirty-seven (37%) in Upper Afram basni were of the view that labour issues and the methods of cultivation must have contributed to the underutilization or erosion of the indigenous crops (Table 4.7).

Table 4.7: Percentage distribution of the reasons for underutilization of some local crop varieties in the study areas

Reasons	**Upper Afram Basin**	**Upper Dayi Basin**
Labour-intensive and time-consuming methods of cultivation	37.09	60.08
Loss of husbandry technologies	10.49	16.73
Seed and harvest lose	8.93	18.63
No attention to genetic improvement and production management	9.9	12.17
Propagation difficulties	9.9	11.41
Low productivity	28.35	42.97
Limited water resources	24.27	28.52
Lack of domestication	0.58	3.8
Mono-cropping	0.19	12.93
Lack of attractive varieties	4.66	18.25
Limited geographical coverage	1.36	8.37
Others	22.9	1.52

Farmers in both study areas again highlighted the challenge of a low productivity as the second major cause of the observed decreased cultivation and marginalization of the indigenous food crop varieties. Upper Afram Basin (UAB) however recorded 22.9% of respondents who mentioned low market demand and bushfires as some of the other causative factors. Responses from interviews with agricultural officers and researchers pointed out factors such as the absence of specific policy provision relating to NUCS and low market demand.

4.3. Agricultural practices

4.3.1 Farming systems

Farming in the study communities within the Upper Afram basin historically has been on a subsistence level involving the use of hoe and cutlass. Due to the availability of large tracts of arable lands and the proximity of the farm lands to their places of residence, households and individuals could easily acquire lands for crop cultivation. Rotational bush fallowing was therefore extensively practiced in the basin. The practice though useful due to its ability to guarantee soil fertility, is not widely practiced anymore as a result of the introduction of agrochemicals and other reasons. Interviews with farmers in the three study communities showed that most farmers now resort to the use of chemicals and therefore are able to use the same piece of land for longer periods. A farmer said:

"With weedicide I clear 5 acres a day, is good, farming now ok"

Majority of the farmers in households within the three (3) selected study communities namely Nokwareasa, Dromankuman and Drobon are engaged in crop farming. Nokwareasa which lies within the middle part of Ejura in the Upper Afram basin comprise mainly farmers who are both

indigenes and settlers. Dromankuman on the other hand is a settler community located within the Upper Afram Basin inhabited by people who migrated from the northern regions to engage in farming. Inhabitants in the Drobon community unlike the other two communities are typical Asantes and comprise mainly indigenous farmers. Mixed cropping is the main system of farming that was practiced by most farmers in the study communities within the basin. Maize is commonly grown in the area and it is usually intercropped with other crops. This practice helped to guarantee or reduce the risk of losing all crop produce or yields. It also ensured the availability of diverse food crops for the household. Only a few small holder farms currently engage in mixed cropping.

The use of chemicals such as weedicides and fertilisers has resulted in the adoption of the monocropping system which involves the cultivation of one particular crop. Ejura in the Upper Afram basin has been noted particularly over the years for the cultivation and production of maize and yam in the Ashanti region and therefore one of the marketing centres for these two important staple crops. The practice of farming has however evolved with the introduction of new technology and large commercial farms. Even though farmers employed simple tools such as hoe and cutlass the introduction of mechanized farming involving the use of ploughs and tractors have largely influenced the practice of farming in the area. Within the basin are commercial farms such as the National Service Scheme Farms which is about a 500-acre maize farm, Pee farms, also about a thousand acres for maize and beans cultivation and the Ejura Camp Prison farm.

Interaction with the MoFA municipal engineer of Ejura, revealed that the farmers are gradually moving away from the manual means of land preparation for farms about a half or more of an

acre to tractor ploughing. This has led to high demand for the tractor services especially during the peak seasons, which is often met with unavailability of tractors. Tractor services are therefore employed from the three Northern regions into Ejura in the Upper Afram basin to support during those periods when their (Northern) season for farming has not yet begun due to their unimodal season.

The study communities within the Upper Dayi Basin (UDB), Likpe-Kukurantumi, Lolobi-Kumasi, and Santrokofi-Benua are all located close to the Dayi River which served as a source of water for agricultural activities. Farmers in the study communities practiced the traditional bush fallow system and also share common cultural and agricultural practices. Majority of farmers in the area are of Guan origin and are believed to have descended from the mountains in search of water.

They then settled in the valley and swampy areas where they engaged in rice farming with family members constituting the main source of farm labour. Farmers in the study communities employed both mixed and monocropping systems. Mixed cropping was practiced in the hilly and upland areas whilst monocropping was employed in the valley or lowland areas. The cultivation of rice is usually intercropped with plantain, yam and cassava. Farming activities was carried out mainly through the traditional use of simple implements such as hoe and cutlass with little mechanization. Chemical use in crop production is also widespread among farmers. According to the farmers, hand tilling of acres of farmlands was practically impossible and therefore the use of chemical was helpful despite its adverse effects on their health.

4.3.2 Agronomic practices

Table 4.8 presents an overview of both the previous and current agronomic practices and their influence on the soil as well as the crops. Common agronomic practices were found to be employed among the farmers in both study areas. The activity of seed sowing which involved broadcasting of seeds by hand especially for cereals is currently being carried out through the use of the pole and line method; and planters particularly for maize cultivation (Table 4.8). Selective weedicides are now commonly used in weed control. Pest control which involved the use of local materials such as cow dung, ash, solutions of neem seed (*Azadirachtin*) extract are also not commonly used now due to the introduction of pesticides including insecticides and rodenticides. Pesticide use in crop production is associated with increased crop yield, however, its abuse or uncontrolled use results in pests either developing resistance or migrating to new environments (Cothran *et al.,* 2013). This effectively often leads to increased incidence of pest outbreak.

Crop rotation and the fallow periods allow farm lands to regain their fertility. In addition, the use of local materials such as chicken droppings, livestock droppings or organic materials also helped in enriching the soil. These practices have declined due to the introduction and use of chemical fertilizers which also help the soil to regain its fertility. When pesticides are used over period of time, new breed of weeds grow on the farm that come to compete with the farmer's grown crops for the resources in the soil (moisture, nutrient, etc.).

Farming in the two study basins is basically rainfed with a few individual farms particularly in the Upper Afram Basin resorting to the use of other sources of water including small scale irrigation systems. Harvesting of crops which was carried out manually using family labour has

been replaced largely by harvesters especially for the large commercial farms found in Upper Afram Basin. Harvested food crops were kept in local silos or barns which provided warmth. Post-harvest loss continues to be a major challenge in both study areas.

Table 4.8 Summary of agronomic practices employed in the study communities

S/N	Agronomic Activity	Previous practice	Current practice	Possible Negative Effect of current practices on Soil/Crops (NUCS)
1.	Land preparation	Use of cutlass and hoe	• Using total non-selective herbicides. • Also use tractors especially in UAB.	• Agrochemical use causes threat to biodiversity; destroying wild to semi-natural habitats (PAN, 2017).
2.	Sowing	Most cereals and other seeds were through broadcast of seeds by hand	• Plant by pole and line. • Very few use planters for maize in UAB.	
Management Practices				
3	Weed control	Weeding with cutlass or hoe	• Use of selective weedicides	• Disrupt functional soil structures and pollination services (PAN, 2017)
4.	Pest control	Use of local materials such as cow dung, ash, solutions of neem, etc. Practice of crop rotations.	• Use of pesticides (insecticides, rodenticides, etc.)	• Agrochemical use increases likelihood of pest outbreaks
5.	Soil enhancer	Using local materials such as chicken droppings, livestock droppings or organic materials. Through crop rotations. Allowing for fallow periods.	• Use of chemical fertilizers	• Agrochemical usage introduces foreign weeds, which rather deplete the soils of moisture and nutrient. (Baishya, K, 2015). • Continuous fertilizer application can lead to acidification of soil which affects most crops (Ogbodo & Onwa, 2013). • Can cause significant variations in the populations of soil

				micro-organisms (Ogbodo & Onwa, 2013)
6.	Harvesting	Hand harvesting.	• Hand harvesting. • Use of harvesters for maize	• Unsustainable harvesting of leaves and bark can affect the survival rate of the crop or population size over the long term (Cocks & Dold (2004); Gaoue & Ticktin, (2008)
7.	Storage	Kept in barns with warmth or kept in local silos.	• Preserved with agrochemicals	
8.	Watering	By rain-fed	• By rain-fed	• Rainfall variability leads to poor growth and yield in crops (Mkonda, 2014)

- *Agrochemical use*

Majority of the local farmers engaged in the study indicated that although the introduction of the agrochemicals has made the land clearing much easier and boosted crop production, its attendant adverse effect on their health was a challenge. The study revealed that there is widespread use (and abuse) of agrochemicals among the farmers in both study areas. Agrochemical use among farmers in the Upper Afram basin for cowpea cultivation started after a farmer demonstration exercise by Adventist Development and Relief Agency (ADRA) around 2013. Total weed killer for example is used for clearing weeds in swampy areas. Commenting on the use of agrochemicals, a crop research officer at Crops Research Institute, CSIR at Ejura explained that agrochemicals have enhanced the production of crops especially weed control through the use of glyphosate, and insecticide for pest control. Among the commonly used agrochemicals in the study areas include fertilizer and pesticides. The pesticides included insecticide, herbicides, weedicide and fungicides (Table 4.9 a and b). Unlike the herbicides and insecticides that were

commonly used in both study areas, fungicides were found to be predominant in Upper Dayi Basin where they are used in cocoa farms.

In Upper Afram basin, the pesticides used belonged to category II and III of WHO/FAO classification of pesticides which are known to be moderately and slightly hazardous chemicals respectively. In addition to category II and III chemicals found in Upper Dayi Basin, category U was also identified, a chemical that is known to present acute hazard in normal use.

Table 4.9a: Mostly used pesticides by farmers in the Upper Afram Basin, active ingredients and WHO/FAO classification

Types of pesticides	Common name	Active ingredients	WHO/FAO classification
Herbicides	*Shye nwura*	41% glyphosate/l	III
	Condemn	Glyphosate 41%	III
	Atrazine liquid	Atrazine 500 G/L SC	III
	Kabasate red	Glyphosate 480g/l	III
	Power	Fenoxaprop-p-ethyl 10 EC	O
Insecticide	Lambda	Lambda-cyhalothrin	II
	Confidor	50 g/L	II
	Sampiriphos	Imidacloprid	II
	Sunpyriphos	Chlorpyrifos ethyl	II
	k-optimal	Lambda-cyhalothrin + Acetamiprid	
	Eradicot T	Maltodextrin	

Note: II = moderately hazardous; III = slightly hazardous; O = Obsolete as pesticide, not classified

Table 4.9b: Mostly used pesticides by farmers in the Upper Dayi Basin, active ingredients and WHO/FAO classification

Types of pesticides	Common name	Active ingredients	WHO/FAO classification
Herbicides	Force up	Glyphosate 360g /L	III
	Round up	Glyphosate 41%	III
	Gramoxone	Paraquat 276 g/L	II
	Kingkeng	Glufosinate ammonium	II
Insecticides	Attack	475 g/l pirimiphos-methyl	II
	Amasta	Acetamiprid	U
	Eradicoat	Maltodextrin	
	Karate 2.5	Lambda- cyhalothrin	II
	Neem seed extracts	2.5g/L Azadirachtin	U
Fungicides	Ridomil Gold	Metalaxyl-M + Cuprous oxide	III

Note: II = moderately hazardous; III = slightly hazardous; U = unlikely to present acute hazard in normal use

Another practice that was common among farmers in Upper Afram Basin is the spraying of weedicides on the field soon after planting. This is done to suppress the emergence of weeds in order to ensure that the crops are able to germinate to a certain height before the weeds begin to grow and compete with the crops. Other farmers also indicated that the introduction of agrochemicals has made it possible to cultivate lands that hitherto were not suitable for crop cultivation. An example is sugarcane lands. Farmers in Upper Afram basin however pointed out the negative effects of the chemicals on some particular crops such as pineapple, cocoyam, *Misewa* (Pepper), *Yaa Asantewaa* (*Solanum sp*.), *Nsusua* (*Solanum sp*.), etc. Officials from MoFA and CSIR-CRI both confirmed the high chemical abuse in both study basins.

4.4 Factors influencing the cultivation and use of NUCS

This section presents results on the factors influencing the decline in the cultivation and use of NUCS in the Upper Afram and Upper Dayi Basins. The environmental and socio-economic factors have been examined under this section.

4.4.1 Environmental factors

4.4.1.1 Climatic variability

Climatic variability over a forty-year period was analysed in order to establish its effect on the diversity of crops in the study areas. The two indicators of climate variability, rainfall and temperature, were used in this study. To better comprehend the trend of climate variability, the rainfall and temperature characteristics in terms of distribution and magnitude were examined. Times series analysis of the secondary data on rainfall and temperature for a 40-year period was conducted. The secondary data was analyzed to show the seasonal variability and extreme events

using INSTAT+ for Windows version 3.6 and descriptive statistics. This was supported with primary data obtained from the field survey. Other aspects of the analysis included the seasonality (that is the wet and dry, hot and cold periods), bi-modal seasons (that is more than one wet or hot season), and changes over a period of time in order to compare the past and present. The analysis and interpretation of quantitative rainfall data (in millimetres) for both Upper Afram and Upper Dayi basins, spanning a 40-year period (1976 to 2016); and the temperature data for both Upper Afram Basin spanning a 40-year period (1976 to 2016); and Upper Dayi Basin spanning a 35-year period (1976 to 2011) based on the availability of data are discussed below. Average rainfall and average temperature figures were used for the analysis. Yearly, monthly and daily data for both rainfall and temperature were analyzed using pattern and trend time series.

- Analysis of rainfall trends in the Upper Afram Basin

Analysis of the rainfall data from 1976 to 2016 showed that the average amount of annual rainfall ranged between 69.5 mm and 131. 1 mm (Table 4.10). The highest amount of rainfall (131.1 mm) was recorded in 2010 and the least amount (69.5 mm) recorded in year 1983.

The annual rainfall figures recorded in the Ejura Sekyedumasi municipal analytical report (GSS, 2014) ranges between 1,200mm and 1,500 mm. Figure 4.5 gives the Annual rainfall in millimetres (mm) for the study communities in Upper Afram basin from 1976 to 2016. Analysis of the rainfall data from 1976 to 2016 in Table 4.9 showed that the annual rainfall figures recorded within the years, 2011, 1976, 1998, 1990, 1977, 2000, 2012, 2001, 2016, 1982, 1994, 1992, and 1983 were below that which was recorded by GSS (2014) lower annual figure of

1200mm while the rainfall figures for the years 2010, 1986, and 1989 were found to exceed the upper limit of 1500mm

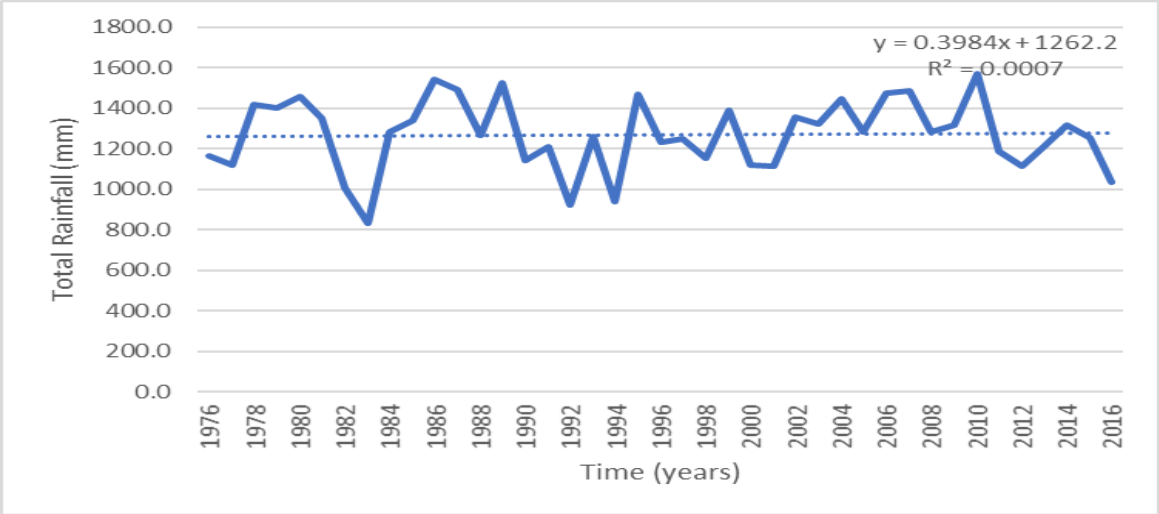


Figure 4.5 Annual rainfall (mm) from 1976 to 2016 for Upper Afram Basin

Table 4.10: Total and mean annual rainfall (mm) from 1976 to 2016 for Upper Afram Basin

Year	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**
Total	1165.7	1120.3	1420.8	1402.6	1461.3	1350.9	1006.8	834.0	1285.5	1338.7
Mean	97.1	93.4	118.4	116.9	121.8	112.6	83.9	69.5	107.1	111.6
Year	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Total	1541.8	1489.9	1264.8	1527.5	1145.3	1209.4	925.7	1262.5	942.6	1469.0
Mean	128.5	124.2	105.4	127.3	95.4	100.8	77.1	105.2	78.6	122.4
Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Total	1234.3	1250.5	1152.6	1390.6	1118.9	1112.9	1356.3	1325.6	1446.1	1286.2
Mean	102.9	104.2	96.1	115.9	93.2	92.7	113	110.5	120.5	107.2
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Total	1473.2	1487.5	1283.6	1319.6	1573.7	1186.5	1114.1	1209.6	1317.1	1256.1
Mean	122.8	124	107	110	131.1	98.9	92.8	100.8	109.8	104.7
Year	**2016**									
Total	1033.3									
Mean	86.1									

- Temperature trends in the Upper Afram Basin

The annual average temperatures as shown in Table 4.11 shows that the minimum temperature (26.4^{o}C) was recorded in the year 1999 while 2010 recorded the highest temperature of 28.4^{o}C. Figure 4.6 gives the plot of the annual average temperature (^{o} C) from 1976 to 2016 for Ejura Sekyedumasi. Figure 4.7 gives climatic graph showing both rainfall and temperature trends with their variability for the Upper Afram basin.

Table 4.11: Annual average temperature (^{o} C) from 1976 to 2016 for Upper Afram Basin

Year	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**
Mean	26.7	27.1	26.7	27.2	27.0	27.0	27.3	27.9	27.3	27.2
Year	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Mean	27.0	27.5	27.5	27.3	27.6	27.4	27.3	27.3	27.2	26.9
Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Mean	26.7	26.6	26.8	26.4	26.6	26.7	27.7	27.5	27.6	27.6
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Mean	27.9	27.8	27.9	28.0	28.4	27.0	26.7	26.8	27.1	27.1
Year	**2016**									
Mean	27.7									

Source: GMet, 2018

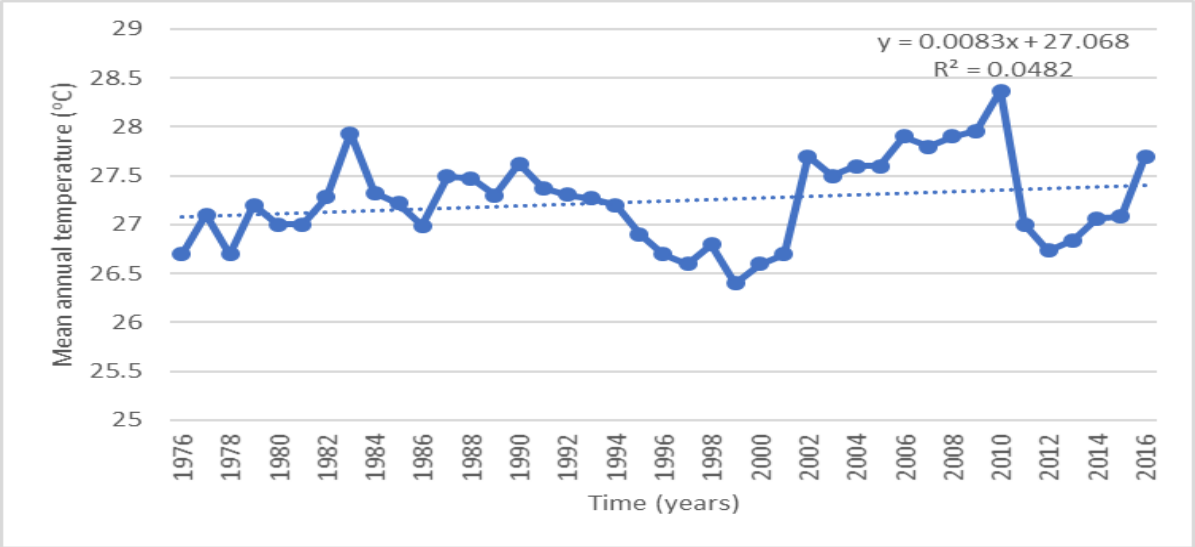


Figure 4.6: Annual average temperature (° C) from 1976 to 2016 for Upper Afram Basin

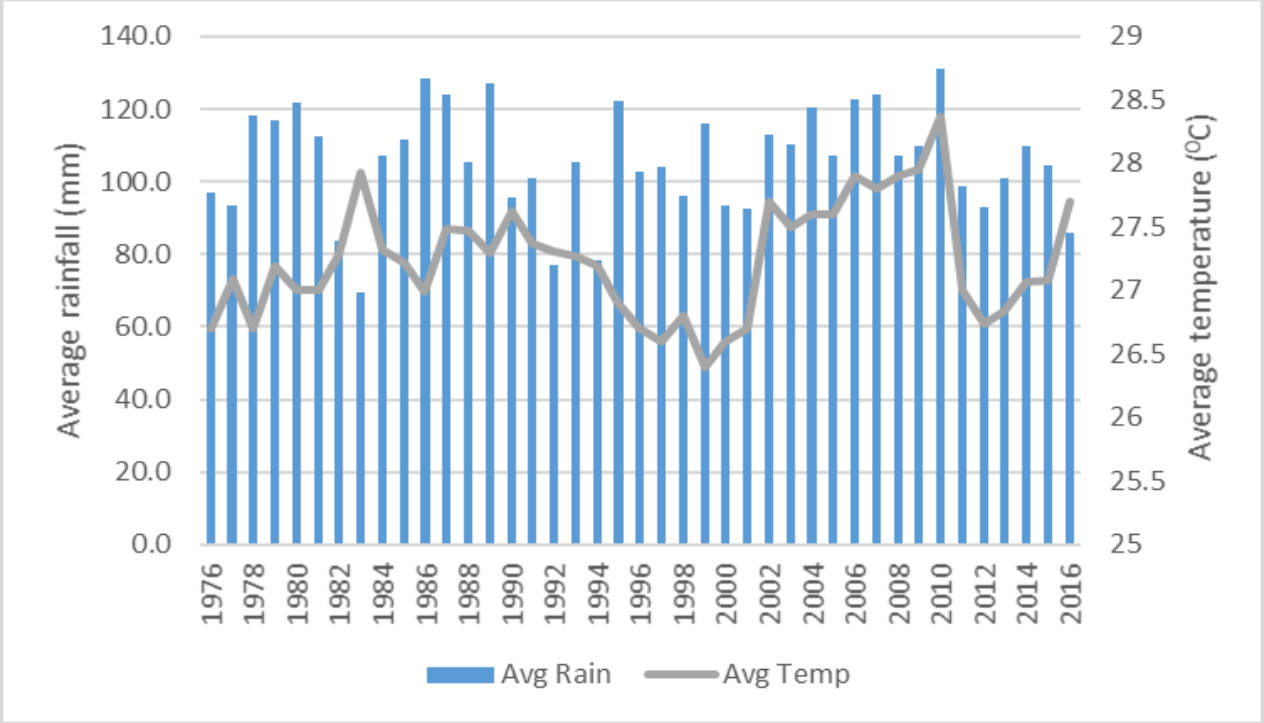


Figure 4.7: Climate graph showing both rainfall and temperature trends for Upper Afram Basin

Analysis of the forty-year climatic data shows that March was the warmest month with August being the coolest month (Figure 4.8). Upper Afram Basin experiences bimodal pattern of rainfall. According to GSS (2014), Ejura experiences raining season from April to November with April to August being the major season whiles the minor season is from August to November. Analysis of the seasonal rainfall records shows strong seasonal variability of rainfall pattern within the study basins. Results from analysis of the secondary rainfall data compared with the current rainfall trend in the area show an anomaly in the rainfall pattern. The major raining season seem to be now shifting towards September and October while a long minor season is being observed from March to July. For the major raining season, the highest peak of rainfall is recorded in June whilst the highest peak in the minor season is recorded in September. More rains were recorded in September which is a minor season than for June, a major season.

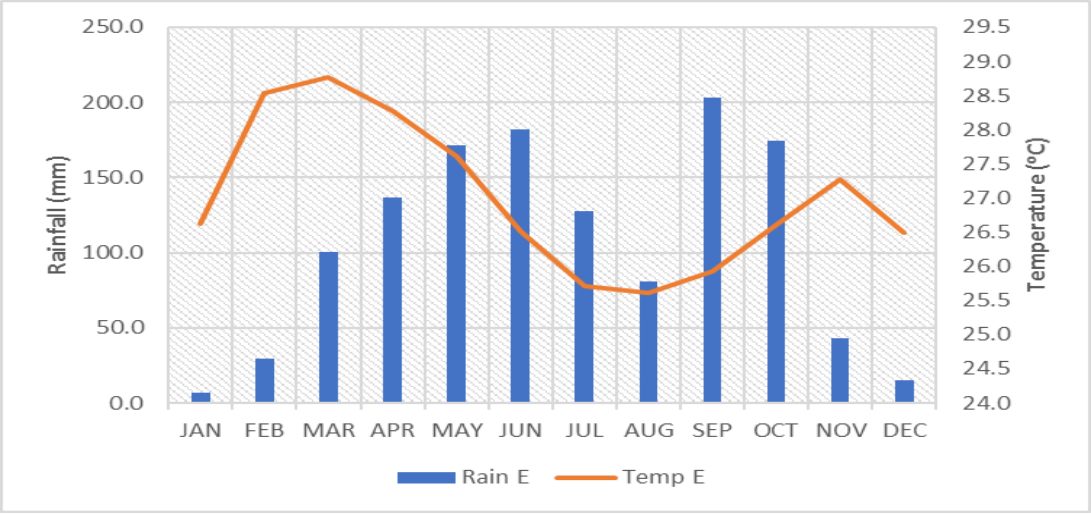


Figure 4.8: Average monthly climate graph for Upper Afram Basin

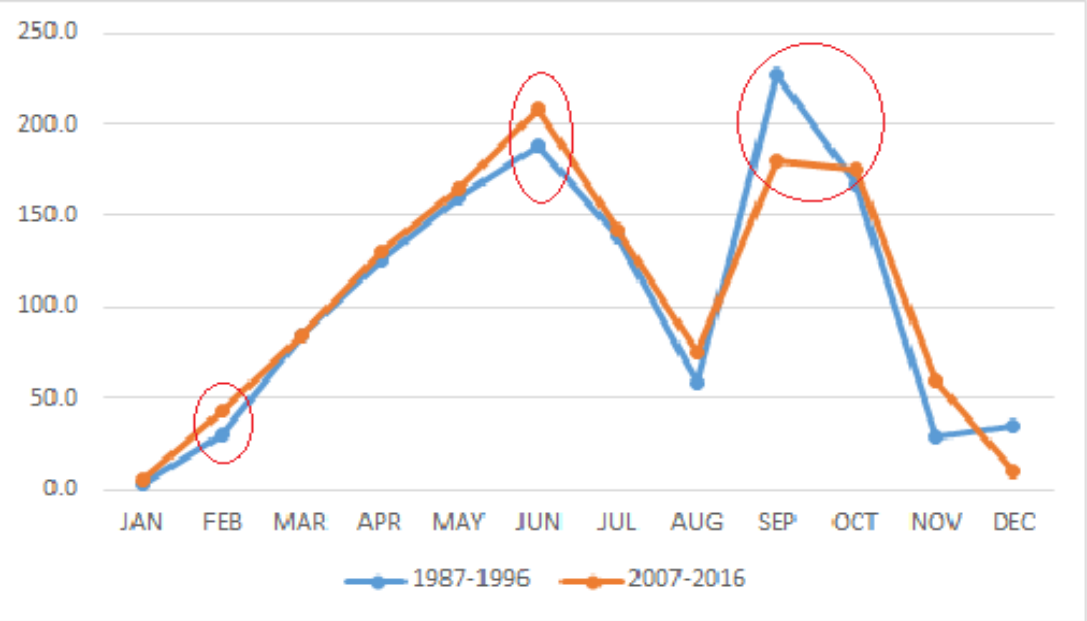


Figure 4.9: Shifts in mean monthly rainfall for Upper Afram Basin

Figure 4.9 shows a change in amount of mean monthly rainfall. Though the average monthly climate graph for Upper Afram Basin from 1976 to 2016 recorded the highest amount of rainfall for September, a downward shift in the magnitude of rainfall between 1987-1996 and 2007-2016 were observed. The study also revealed that rainfall generally has now become erratic with extremes that normally lead to flooding and drought. According to the farmers, the erratic nature of the rains is making it difficult to predict the farming seasons. This was highlighted as a major challenge by majority of the farmers.

- Analysis of rainfall trends in the Upper Dayi Basin

Results of the rainfall data analysis for the period starting from 1976 to 2016 showed that the average amount of annual rainfall ranged between 66.9 mm and 162.9 mm (Table 4.12). The

highest amount of rainfall (162.9 mm) was recorded in 2013 and the least amount (66.9 mm) recorded in the year 1982 (Figure 4.10).

Table 4.12: Annual average rainfall (mm) from 1976 to 2016 for Upper Dayi Basin

Year	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**
Mean	133.6	74.8	90.7	139.8	91.6	116.9	66.9	88.0	106.9	115.5
Year	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Mean	85.1	118.7	100.2	120.5	126.4	128.3	97.7	114.1	99.6	146.1
Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Mean	96.1	117.7	96.3	124.5	93.7	86.0	116.3	124.2	95.5	88.5
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Mean	147.4	121.5	105.9	121.2	113.5	105.7	116.8	162.9	91.6	99.5
Year	**2016**									
Mean	72.0									

Source: GMet, 2018

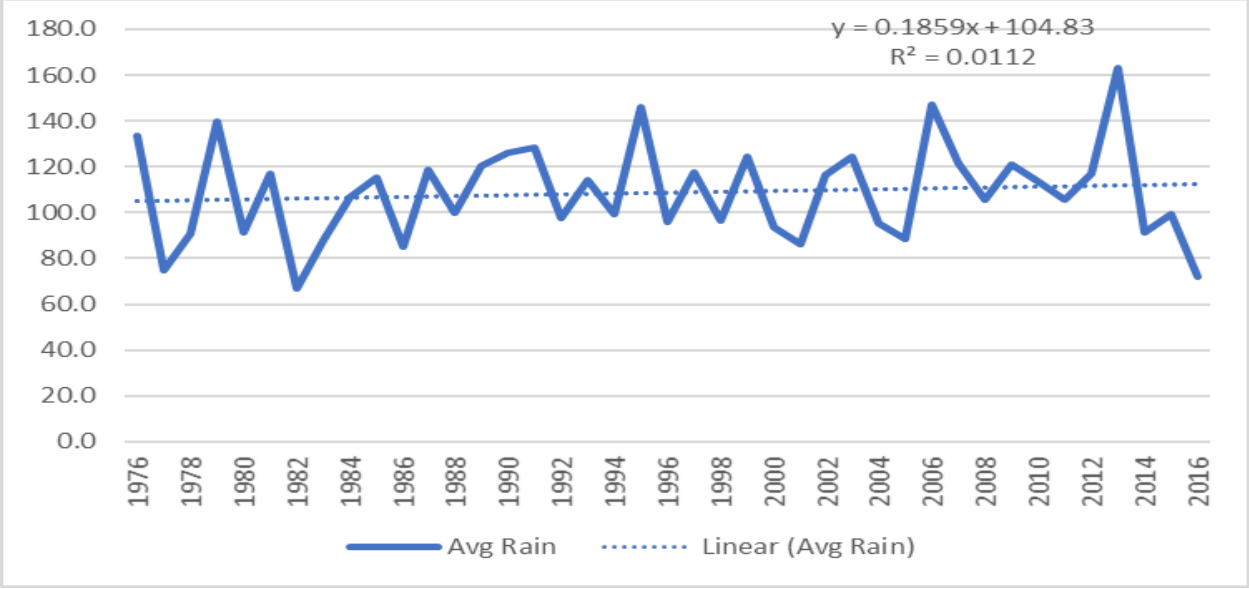


Figure 4.10: Average rainfall (mm) from 1976 to 2016 for Upper Dayi Basin

The average annual rainfall total of the Upper Dayi basin is 1300mm. The rainfall pattern in the basin is considered to be mainly bimodal with the major rains starting from April through to July while the minor season covers the period from September through to November (Figure 4.11).

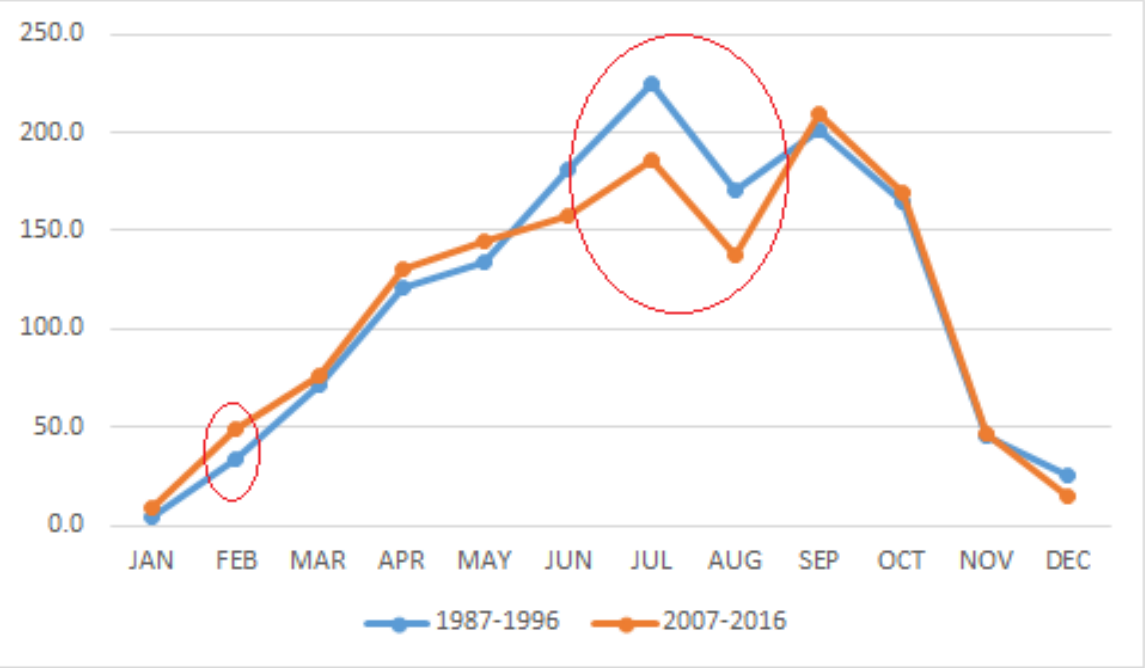


Figure 4.11: Shifts in mean monthly rainfall in Upper Dayi Basin

The rainfall anomaly graph in Figure 4.12 showed that the annual rainfall figures for about half of the years [1984, 2008, 2011, 1988, 1994, 2015, 1992, 1998, 1996, 2004, 2000, 2014, 1980, 1978, 2005, 1983, 2001, 1986, 1977, 2016, and 1982] studied from 1976 - 2016 were below the municipality's annual average rainfall of 1300 mm whilst the remaining half also were above the average figure. There is however, much variability in rainfall in Upper Dayi Basin. Shifts and changes in magnitude of mean monthly rainfall are also captured in figure 4.11.

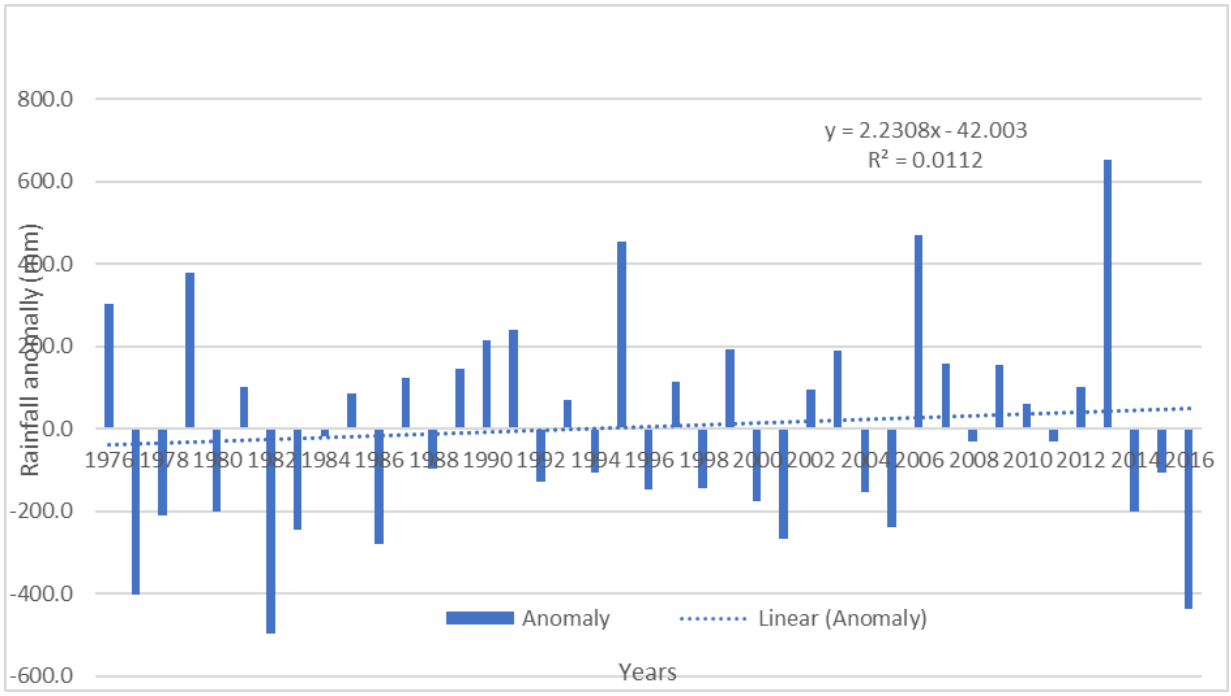


Figure 4.12: Rainfall Anomaly in Upper Dayi Basin from 1976 -2016

- Analysis of temperature trends in the Upper Dayi Basin

The annual average temperature for Upper Dayi basin as shown in Table 4.13 depicts that 1996 recorded the minimum temperature (22.5^{o}C) while 1979 recorded the highest temperature of 30.5^{o}C (Figure 4.13).

Table 4.13 Annual average temperatures (º C) from 1976 to 2011 for Upper Dayi Basin

Year	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**
Mean	25.8	26.7	25.1	30.5	26.6	26.6	26.6	27.1	27.5	26.9
Year	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Mean	26.5	27.1	26.5	26.6	26.9	26.3	26.1	26.9	26.8	26.1
Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Mean	22.5	26.0	27.8	27.2	27.4	27.5	28.1	27.9	27.6	27.5
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**				
Mean	27.4	27.5	27.3	27.5	28.1	26.9				

Source: GMet, 2018

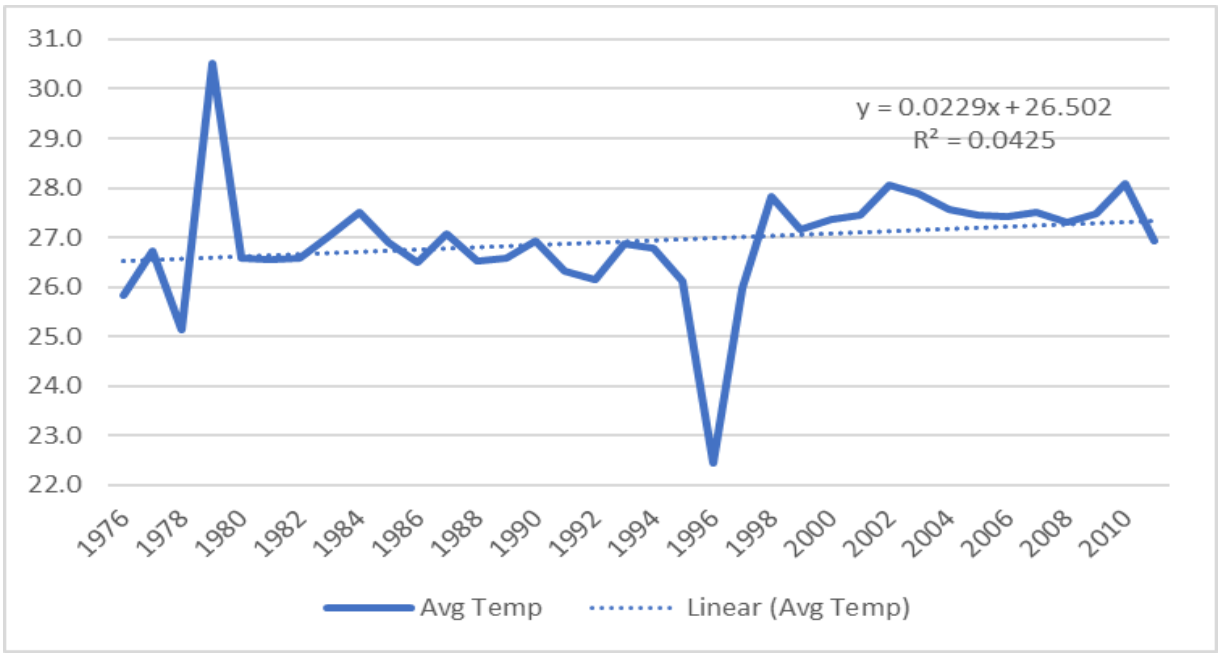


Figure 4.13: Average temperature (º C) for Upper Dayi Basin

As observed from the average monthly climate graph (Figure 4.14) for Upper Dayi Basin, the two generally known distinct raining seasons might be giving way to a long unimodal system as observed also in Upper Afram Basin. The analysis of the 40-year rainfall data showed that September which is considered a minor season recorded the highest rainfall (Figure 4.15).

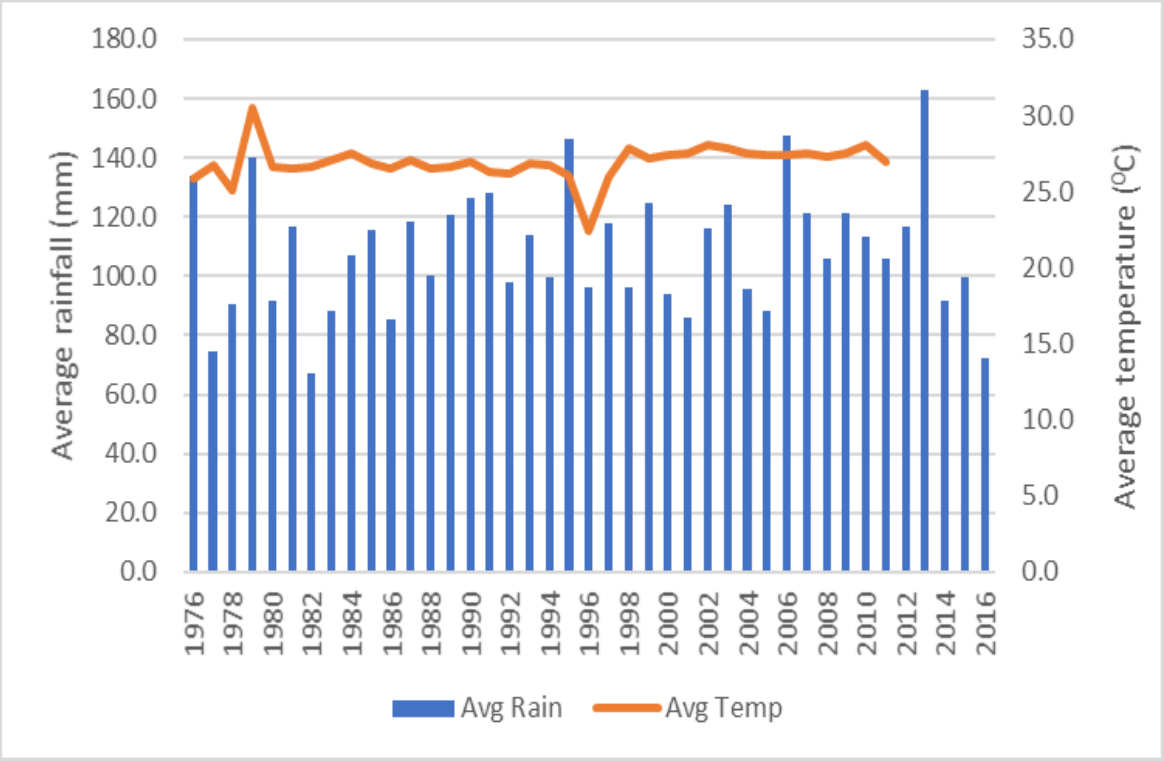


Figure 4.14: Climate graph showing both rainfall and temperature trends for Upper Dayi Basin

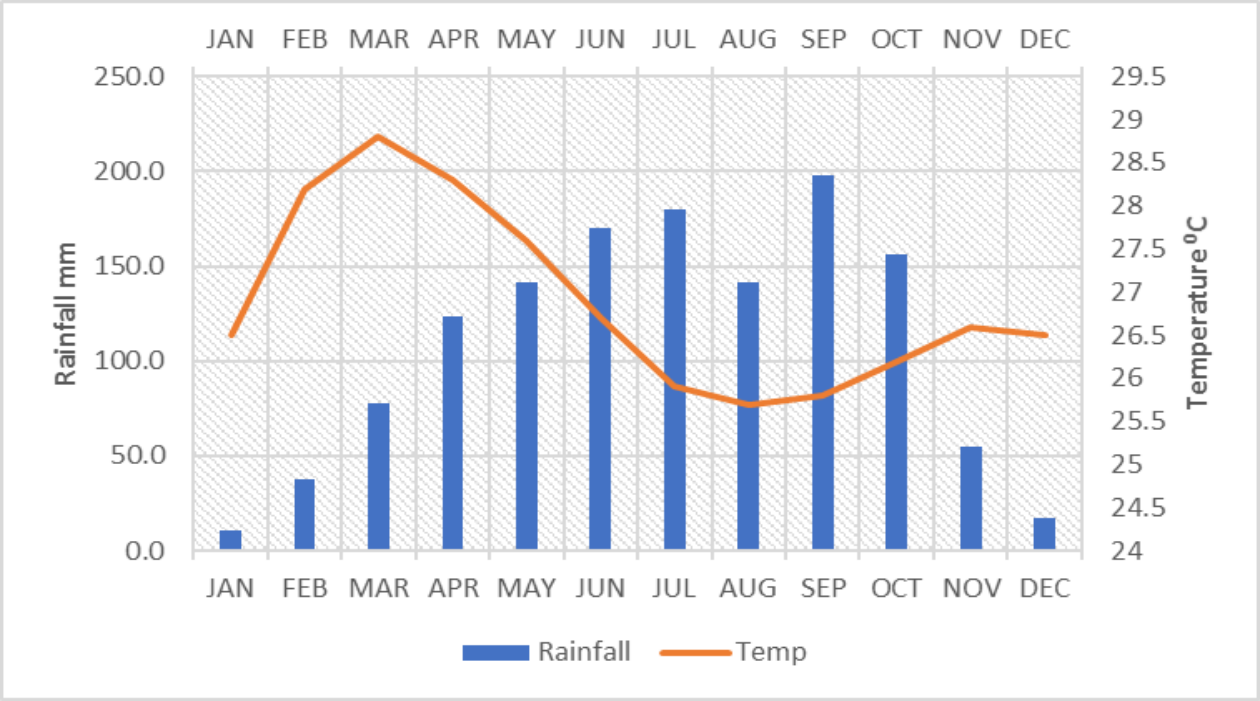


Figure 4.15: Average monthly climate for Upper Dayi Basin from 1976 – 2016

4.4.1.2. Land use and land cover changes

The supervised classification method was used to generate land cover maps of the two study areas. Three (3) images of land cover maps were generated for the year 2000, 2010, and 2018. Land use land cover (LULC) classes were then identified from the land cover maps. The characteristics of the land cover types are described in Table 4.14. The land cover types that were used in the LULC analysis for the study included the closed canopy; the open canopy; the dense shrub; grass or herbaceous; bare surface or built up area and waterbody. The three land cover maps are presented in Figure 4.16 for Upper Afram Basin and Figure 4.19 for Upper Dayi Basin.

Table 4.14: Description of land cover classification scheme used for the study

Land cover (LC) type	Description
Closed canopy very active bushes	This includes secondary forest and some few untouched forests for which there is at least some canopy cover. This may include forest reserves or sacred groves and forest patches.
Open canopy	This represents vegetation with no canopy but have sparse distribution of trees. This includes trees with no canopy and shrub areas.
Dense shrub	Lands ever used for food production in whatever form, for which the natural vegetation cover has been tampered with resulting in an irreversible change. Examples are Cultivated or fallow lands or a grazing land.
Grass/herbaceous	Lands covered by herbaceous plants and shrub canopies
Bare surface/built up area	Areas with no vegetation cover and exposed soil surfaces. Examples include settlements, roads and rock surfaces.
Water body	Areas covered by water for most parts of the year, at both wet and dry seasons. This includes rivers and streams.

- Land use and Land cover (LULC) analysis for the Upper Afram Basin

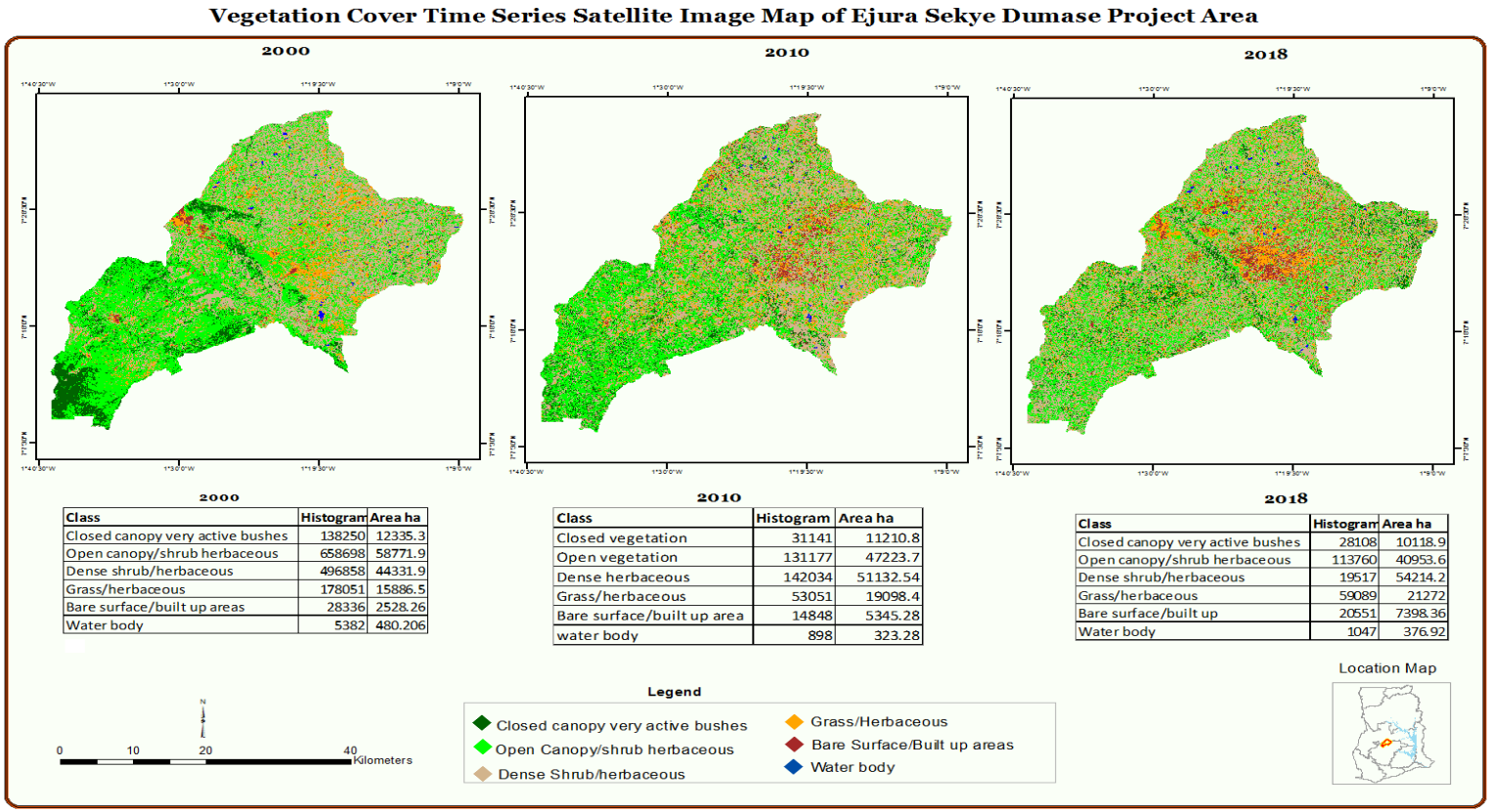


Figure 4.16: Land Use Map of Upper Afram Basin Source: CERGIS, 2018

Table 4.15: Matrix of Land cover by class values for the years 2000, 2010 and 2018 in Upper Afram Basin

	LC Distribution						LC Changes (%)		
	2000		2010		2018		2000-2010	2010-2018	2000-2018
LC Types	Area (Ha)	%	Area (Ha)	%	Area (Ha)	%			
Closed canopy very active bushes	12335.3	9.2	11210.8	8.3	10118.9	7.5	-9.12	-9.74	-17.97
Open canopy/shrub herbaceous	58771.9	43.7	47223.7	35.2	40953.6	30.5	-19.65	-13.28	-30.32
Dense shrub/herbaceous	44331.9	33	51132.54	38.1	54214.2	40.4	15.34	6.03	22.29
Grass/herbaceous	15886.5	11.8	19098.4	14.2	21272	15.8	20.22	11.38	33.90
Bare surface/built up area	2528.26	1.9	5345.28	4	7398.36	5.5	111.42	38.41	192.62
Water body	480.206	0.4	323.28	0.2	376.92	0.3	-32.68	16.59	-21.51
Total	**134334**	100	**134334**	100	**134334**	100			

Source: CERGIS, 2018

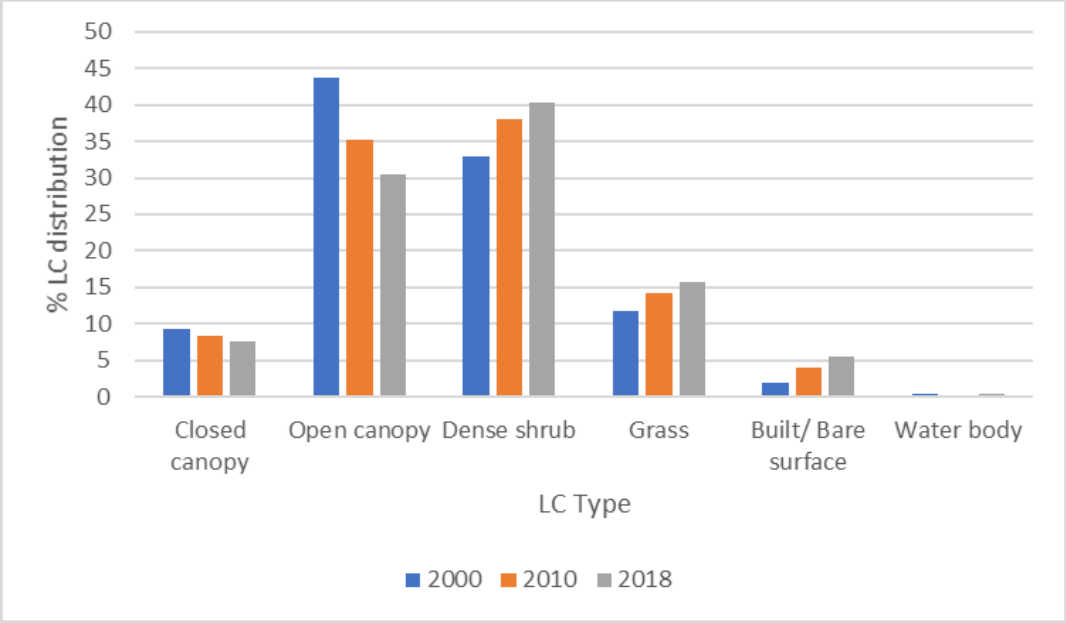


Figure 4.17: Land cover for Upper Afram Basin

Results of the land cover analysis for the Upper Afram in Table 4.15 and Figure 4.17 indicate that in 2000 Open canopy was the predominant cover, recording the highest percentage of almost 44. Dense shrub was the most dominant cover in both 2010 and 2018 recording 38% and 40% respectively. Analysis of the land use data for the Upper Afram Basin showed a decline in both closed canopy and open canopy coverage areas during the periods 2000 to 2018 (Figure 4.18). A gradual decline of closed canopy from 12335.3 ha (9.2%) in 2000 to 11210.8 ha (8.3%) in 2010 and then to 10118.9 ha (7.5%) in 2018 was observed. A similar pattern of decline was also observed for the Open canopy, decreasing from 58771.9 ha (43.7%) in 2000 to 47223.7 ha (35.2%) in 2010 and then to 40953.6 ha (30.5%) in 2018.

A pattern of increase however was recorded for the dense shrub, grassland and built/bare surface coverage. Dense shrub increased from 44331.9 ha (33%) in 2000 to 51132.54 ha (38.1%) in 2010, and to 54214.2 ha (40.4%) in 2018. Grass coverage at 15886.5 ha (11.8%) in 2000 increased to 19098.4 ha (14.2%) in 2010 and then to 21272 ha (15.8%) in 2018 (Table 4.15).

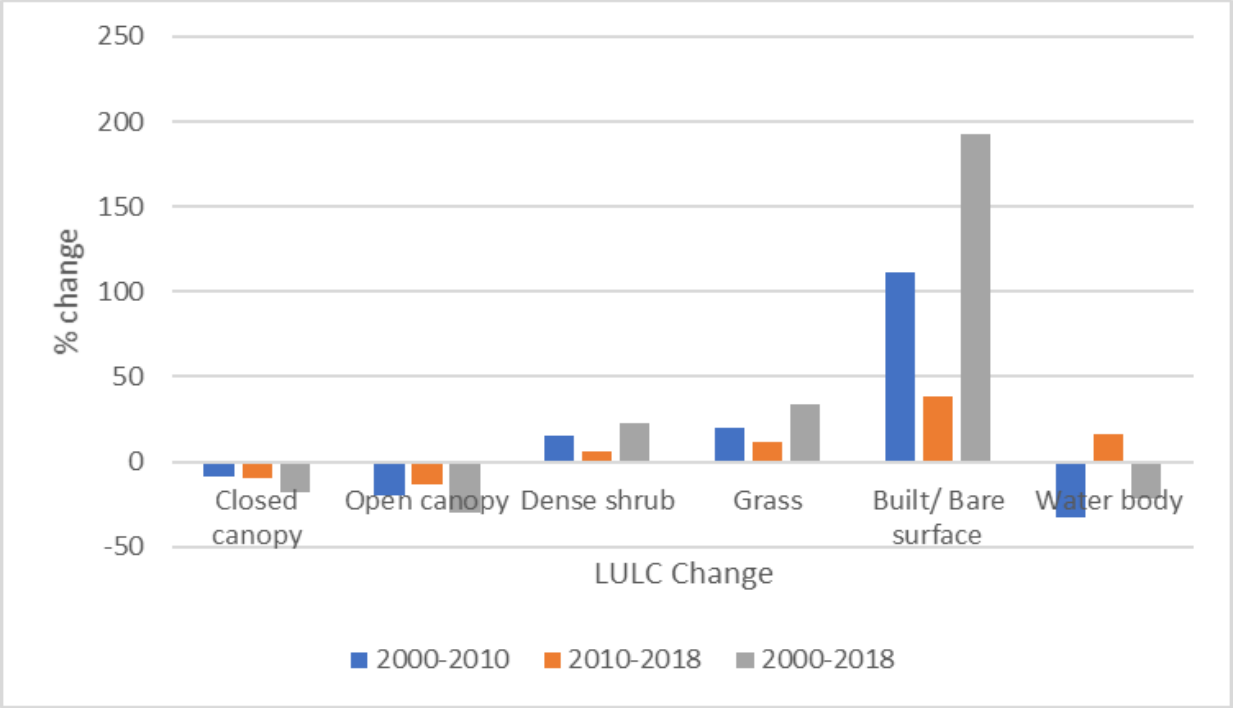


Figure 4.18: Land use land cover change trend for Upper Afram Basin from 2000-2018

Bare/built up area at 2528.26 ha (1.9%) in 2000 increased to 5345.28 ha (4%) and 7398.36 ha (5.5%) in 2010 and 2018 respectively. The water body on the other hand recorded 480.21 ha (0.4%) in 2000 but decreased in 2010 to 323.28 ha (0.2%) and then increased again to 376.92 ha (0.3%) in 2018.

The closed canopy vegetation in Upper Afram Basin lost 9% of its coverage to the other land cover types during the ten-year period of 2000 and 2010. The open forest vegetation also lost

about 20% of its coverage during the same period to other classes of land cover. There was however a gain of 15% for dense shrub, 20% for grassland and 111% for bare/built up surface within the same period of 2000 to 2010. The water body lost about 33% of its coverage during this period. During the period 2010 to 2018, some changes were observed as well in the land cover types. Both closed and open canopy lost some cover (about 10% and 13% respectively). All other land cover types gained in coverage; dense shrub, grass, bare/built and water body gained 6%, 11%, 38% and 17% respectively. For the periods 2000 to 2018, closed canopy lost about 18% whilst open canopy also lost 30% of the coverage. Dense shrub, grass, and bare/built gained 22%, 34% and 193% respectively. The water body however lost over 21% of its coverage during this period (Figure 4.18).

- Land use and Land cover (LULC) analysis for the Upper Dayi Basin

The results of the land cover analysis for Upper Dayi basin (Table 4.16 and Figures 4.19 & 4.20) generally show a decline in both closed and open vegetation cover from 2000 to 2018. Closed vegetation of 29294.00 ha (42.67%) in 2000 reduced to 20039.4 ha (29.19) in 2010 and further declined to 16147.70 (23.52%) in 2018.

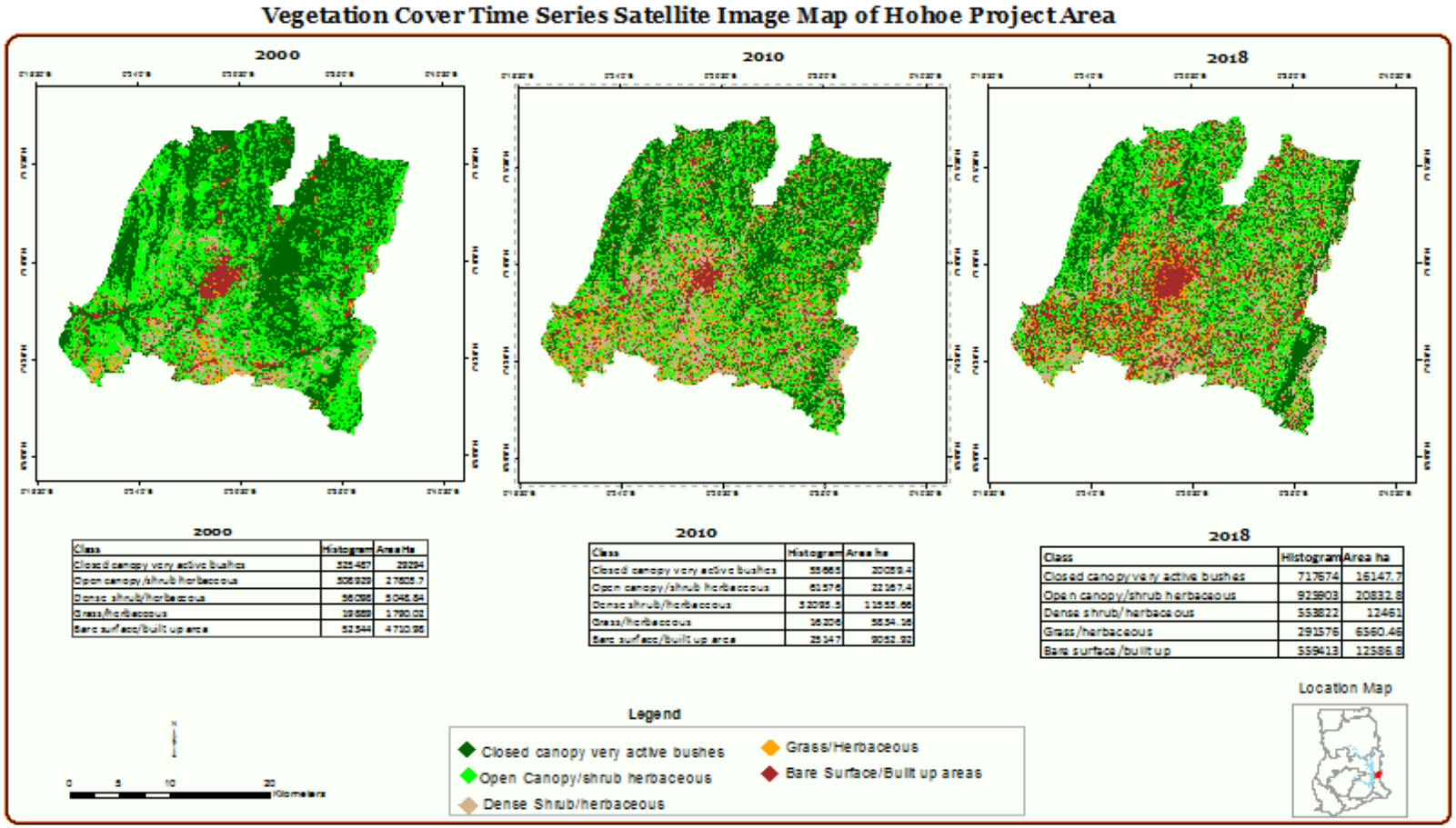


Figure 4.19: Land Use Map of Upper Dayi Basin Source: CERGIS, 2018

Table 4.16: Matrix of Land Cover by Class Values for the years 2000, 2010 and 2018 in Upper Dayi Basin

	LC Distribution						LC Changes (%)		
	2000		2010		2018		2000-2010	2010-2018	2000-2018
LC Types	Area (Ha)	%	Area (Ha)	%	Area (Ha)	%			
Closed canopy very active bushes	29294.00	42.67	20039.4	29.19	16147.70	23.52	-32	-19	-45
Open canopy/shrub herbaceous	27803.70	40.50	22167.4	32.29	20891.58	30.43	-20	-6	-25
Dense shrub/herbaceous	5048.84	7.35	11553.66	16.83	12461.00	18.15	129	8	147
Grass/herbaceous	1790.02	2.61	5834.16	8.50	6560.46	9.56	226	12	267
Bare surface/built up area	4710.98	6.86	9052.92	13.19	12586.80	18.33	92	39	167
Total	**68647.54**	100	**68647.54**	100	**68647.54**	100			

Source: CERGIS, 2018

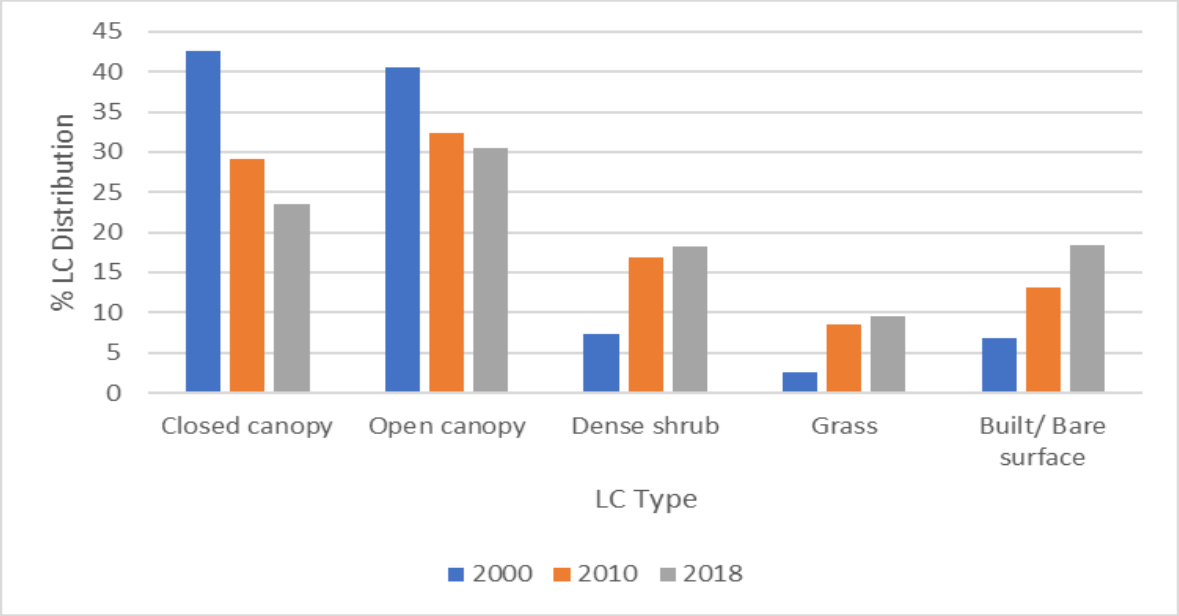


Figure 4.20: Land cover for Upper Dayi Basin

Open vegetation covers also reduced from 27803.70 ha (40.50%) in 2000 to 22167.4 ha (32.29) in 2010 and continued to decline to 20891.58 (30.43) in 2018. Dense shrub, grassland and built/bare surface coverage however, increased over the years. Dense shrub coverage increased from 5048.84 ha (7.35%) in 2000 to 11553.66 ha (16.83%) in 2010 and then to 12461 ha (18.15%) in 2018. Grass coverage increased from 1790.02 ha (2.61%) to 5834.16 ha (8.50%) and then to 6560.46 ha (9.56%) in 2000, 2010 and 2018 respectively. Built up/ bare area increased from 4710.98 ha (6.86%) in 2000, to 9052.92 ha (13.19%) in 2010 and then to 12586.80 ha (18.33%) in 2018.

The closed canopy vegetation in Hohoe lost as much as 32% of its coverage to the other land cover types within the ten-year period of 2000 and 2010. The open forest vegetation also lost 20% of its coverage during the same period to other types of land cover such as dense shrub, grassland and built/bare surface. A gain of 129% for dense shrub, 226% for grassland and 92% for bare/built up surface within the same period of 2000 to 2010 was recorded.

The land cover changes for the period 2010 to 2018 showed gradual changes. Both closed and open canopy lost part of their vegetation (-19%, and -6% respectively) to the other land cover types. Dense shrub, grassland and bare/built up areas however gained 8%, 12% and 39% respectively, during this same period. Between the periods 2000 and 2018, close to half (45%) of the closed canopy of the Hohoe has been lost. Open canopy has also lost 25% of its cover. Dense shrub gained 147%, whilst grassland recorded the highest (267%) and bare/built up area gained 167% (Figure 4.21).

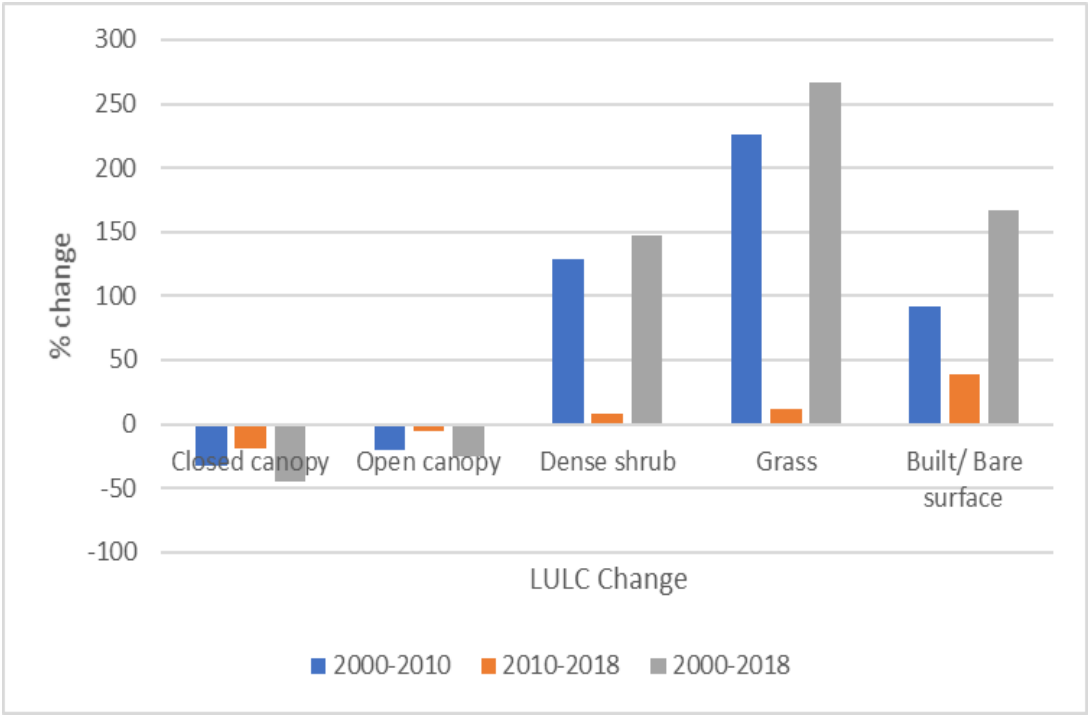


Figure 4.21: Land use land cover change trend for Upper Dayi Basin from 2000-2018

- Comparison of the LULC between the Upper Afram and Upper Dayi Basins

The percentage coverage of closed forests in the two basins is presented in Figure 4.22a. Upper Afram Basin (UAB) recorded only 9.2% in 2000 whilst Upper Dayi Basin (UDB) had over 42% closed forest coverage.

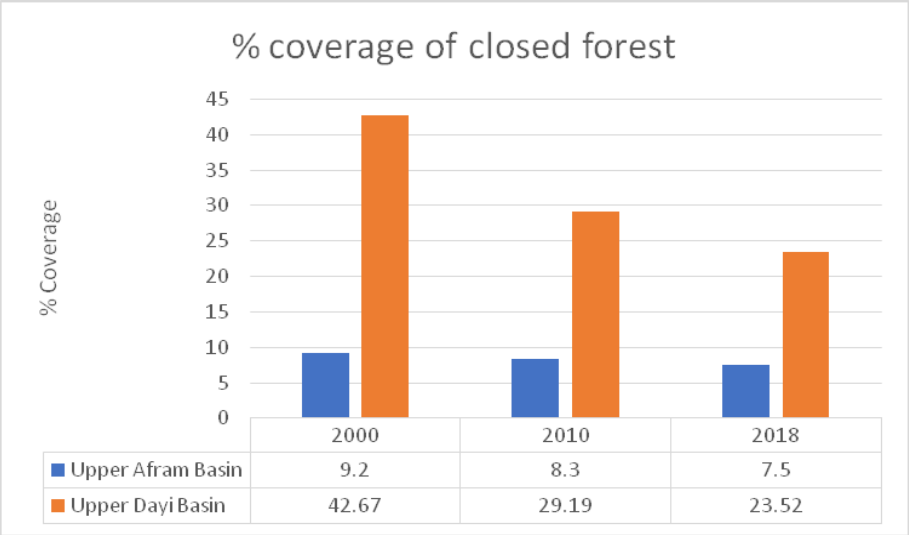


Figure 4.22a Percentage coverage of closed forest vegetation for UAB and UDB per years

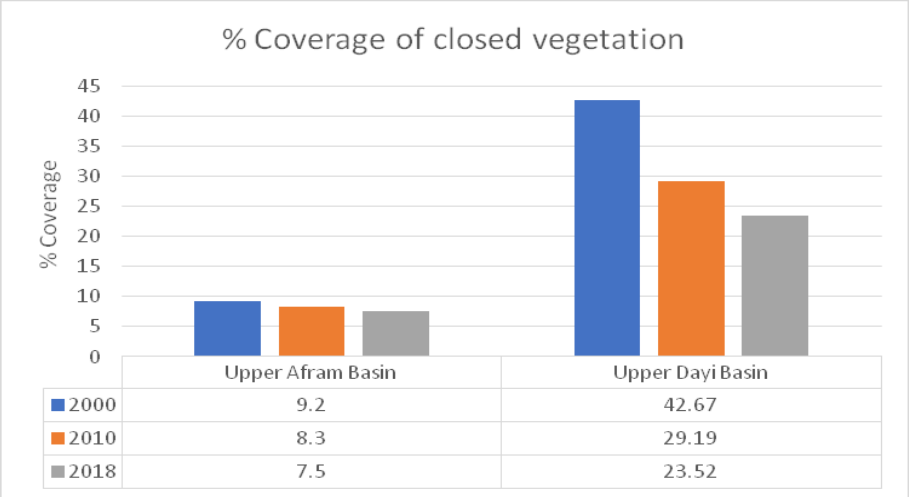


Figure 4.22b Percentage coverage of closed forest vegetation per Basins

A decline in the closed forest cover in the two basins over the periods from 2000 to 2018 was observed even though that in Upper Dayi Basin was more drastic (Figure. 4.22b). Figure 4.23 showed that the percentage of grass coverage in Upper Afram basin was relatively higher than that of Upper Dayi basin.

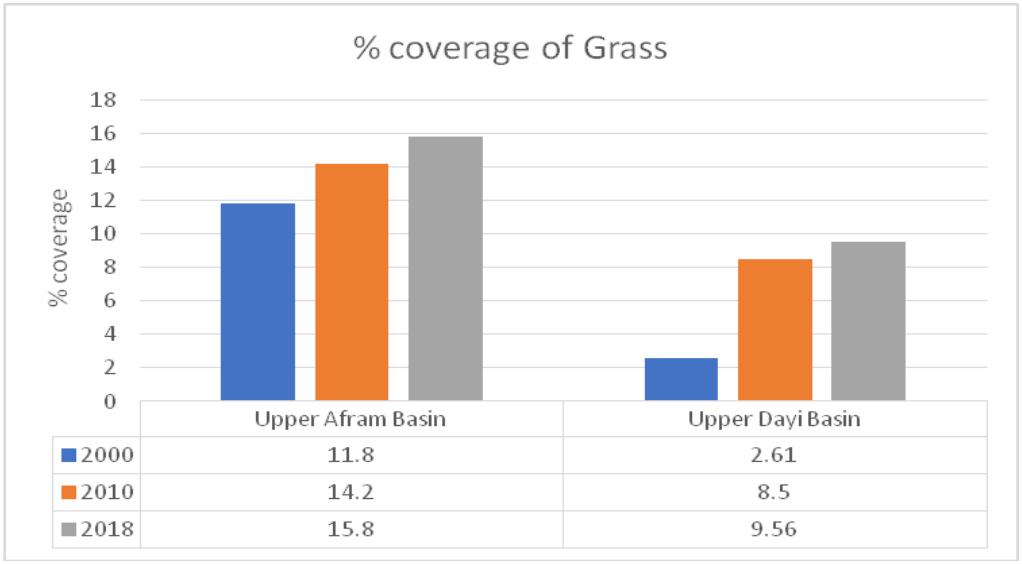


Figure 4.23: Percentage coverage of Grass at UAB and UDB between 2000 and 2018

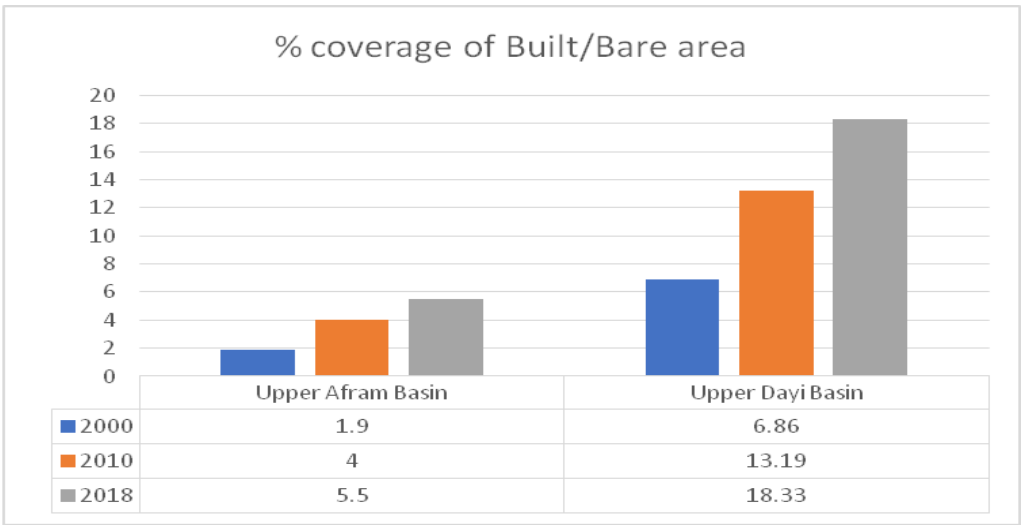


Figure 4.24: Percentage coverage of Built up/Bare area at UAB and UDB between 2000 and 2018

Table 4.17: Population growth, Forest cover change and other LULC classes for Upper Afram Basin

	Population (census & projection)			Forest Cover (ha)				Other LULC classes		
Year	2000	2010	2018		2000	2010	2018	2000	2010	2018
				CC	12335.3	11210.8	10118.9			
				OC	58771.9	472237	40953.6			
Total	**81115**	**85446**	**102291**		**71107.2**	**58434.5**	**51072.5**	**63226.8**	**75899.5**	**83261.5**

The rate of population growth within the Upper Afram Basin increased within the period from 2000 to 2018 (Table 4.17); whilst forest cover reduced considerably over the same period of years. This implies that forest cover is depleted at excessive rates. From the 2010 population census of Ghana it was observed that between 2000 and 2010 the population in the municipality grew by about 5% and between 2010 and 2018 it grew by about 20%.

The forest cover decreased by an amount of 12672.7 ha (17.8%) and 7362 ha (12.6%) from 2000 to 2010 and 2010 to 2018 respectively. A total amount of 20034.7 ha representing 30.4%. of the forest cover was depleted between 2000 to 2018. The combined areas of the other LULC classes increased along the years.

Table 4.18: Population growth, Forest cover change and other LULC classes for Upper Dayi Basin

	Population (census & projection)			Forest Cover (ha)				Other LULC classes		
Year	**2000**	**2010**	**2018**		**2000**	**201 0**	**2018**	**2000**	**2010**	**2018**
				CC	29294.0	20039.4	16147.7			
				OC	27803.7	22167.4	20891.6			
Total	**144502**	**167016**	**201190**		**57097.7**	**42206.8**	**37039.3**	**11549.8**	**26440.7**	**31608.3**

The rate of population growth within the Upper Dayi Basin increased over the two-decade period from 2000 to 2018 (Table 4.18); whilst forest cover reduced considerably over the same period of years. This implies that forest cover is consumed at excessive rates. From the 2010 population census of Ghana it was observed that between 2000 and 2010 the rate of population in the municipality grew by about 16% and between 2010 and 2018 it grew by about 20%. The forest cover decreased by an amount of 14890.9 ha (26%) and 5167.52 ha (12%) from 2000 to 2010 and 2010 to 2018 respectively. Therefore, the total decrement of the forest from 2000 to 2018 is 20058.42 ha representing 38%. The combined areas of the other LULC classes increased along the years.

- Accuracy assessment

Table 4.19: Accuracy Assessment of Upper Afram Basin

Accuracy (%)				
Class	**Omission Error**	**Producer**	**Commission Error**	**User**
Closed canopy	11%	89%	15%	85%
Open canopy	20%	80%	16%	84%
Dense shrub	17%	83%	21%	79%
Grass/herbaceous	17%	83%	12%	88%
Bare surface/built up	7%	93%	13%	88%
Water body	10%	90%	0%	100%
Overall Accuracy		86%		
Kappa Coefficient		0.8305		

From the classification accuracy assessment performed on the 2018 LULC map for Upper Afram Basin, an assessment report gave an error matrix, accuracy totals and a kappa statistic (Appendix C). The overall classification accuracy was 86% and a Kappa coefficient (Overall Kappa Statistics) of 0.8305 was recorded (Table 4.19 & Appendix C). The 86% overall

accuracy recorded in Table 4.19 is acceptable as it agrees with Turan and Günlü (2010) acceptable overall accuracy (which requires the overall accuracy to be greater than 80%).

Table 4.20. Accuracy Assessment of Upper Dayi Basin

Accuracy (%)				
Class	**Omission Error**	**Producer**	**Commission Error**	**User**
Closed canopy	11%	89%	11%	89%
Open canopy	16%	84%	6%	94%
Dense shrub	12%	88%	17%	83%
Grass/herbaceous	19%	81%	24%	76%
Bare surface/built up	14%	86%	14%	86%
Overall Accuracy		85.88%		
Kappa Coefficient		0.8231		

From the classification accuracy assessment performed on the 2018 LULC map for the Upper Dayi basin, an assessment report gave an error matrix, accuracy totals and a kappa statistic (Appendix D). An overall Classification accuracy of 85.8% and a Kappa coefficient (Overall Kappa Statistics) of 0.8231 was achieved (Table 4.20 and Appendix D). This also fell within Turan and Günlü (2010) overall accuracy acceptable range.

4.4.2 Socio-economic factors

4.4.2.1 Market dynamics

The market survey that was undertaken during the study targeted the major markets in the Upper Afram and Upper Dayi basins. The survey elicited views of farmers, traders, representatives of agricultural marketing associations; individual market men and women, on the general trend in demand and marketing of agricultural food crops and the influence of market forces on NUCS cultivation and commercialization in the two river basins. The traders who also provided consumer perspective on crops that were previously sold on the

market but presently unavailable due to market forces of demand and supply have also been presented.

- *Views of farmers on market dynamics and NUCS*

In this section, a sample of the NUCS has been selected and the views of farmers on their market dynamics have been presented.

Figure 4.25 shows that less than 20% of farmers cultivated *Agushie* for the market or commercial purposes. Amaranth, Basil (*Akoko besa*) and pumpkin were produced solely for domestic consumption. *Ayoyo* also called *Ademe* is very much patronized in the Upper Dayi basin. Ayoyo which is a leafy vegetable comparable to Amaranth is produced by 53% of farmers for the market while 47% of the farmers cultivated it for domestic consumption.

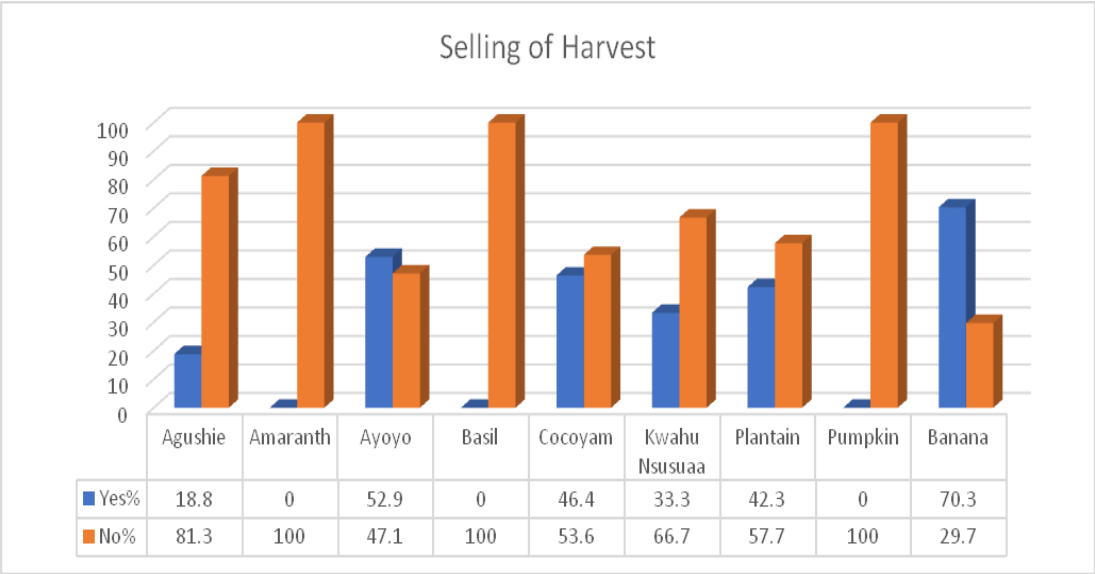
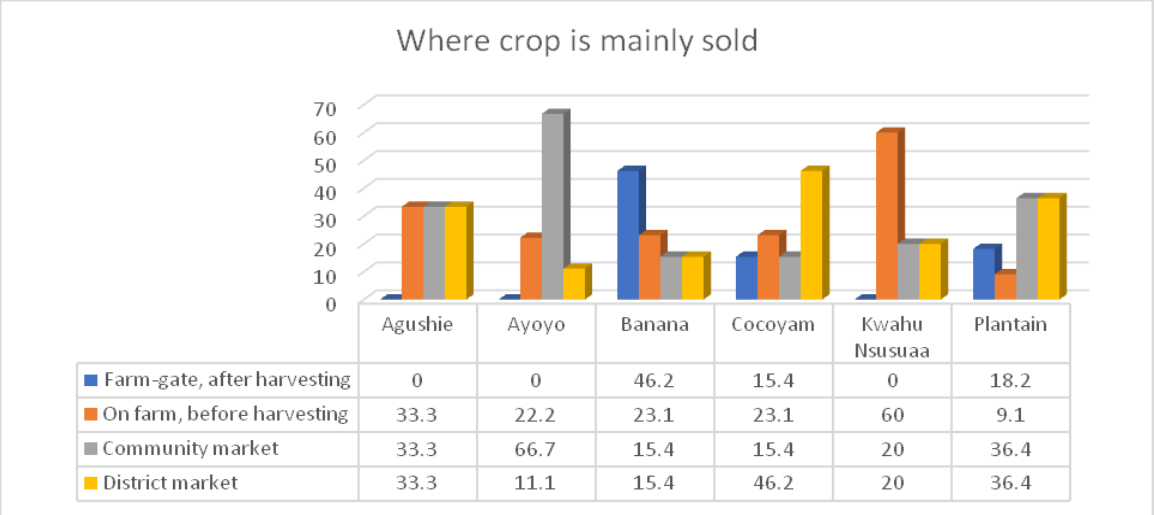


Figure 4.25 Food crop cultivated for domestic and commercial purposes

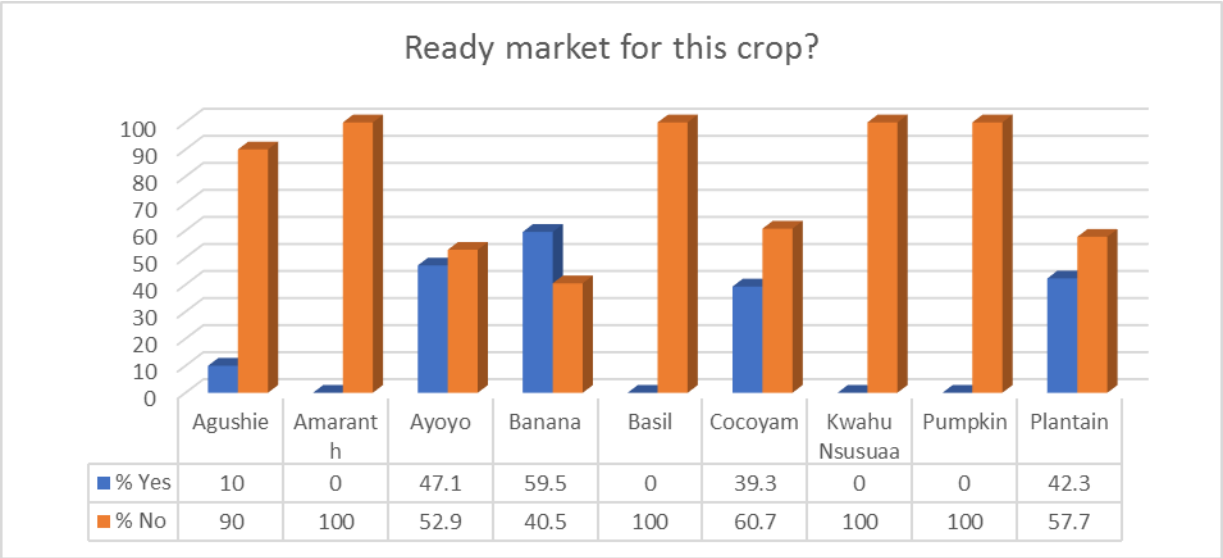
Figure 4.26 shows that *Agushi* is sold on the farm before harvest, at the community market or the municipal market. *Ayoyo* is mostly sold at the community market mainly due to its perishable nature and inability to stay long enough till the market days of the municipality.

Kwahu nsusua (*Solanum sp*.) on the other hand does not have a defined season for harvesting and marketing, hence usually sold on the farm.



	Agushie	Ayoyo	Banana	Cocoyam	Kwahu Nsusuaa	Plantain
Farm-gate, after harvesting	0	0	46.2	15.4	0	18.2
On farm, before harvesting	33.3	22.2	23.1	23.1	60	9.1
Community market	33.3	66.7	15.4	15.4	20	36.4
District market	33.3	11.1	15.4	46.2	20	36.4

Figure 4.26 Different marketing locations where crops are sold



	Agushie	Amaranth	Ayoyo	Banana	Basil	Cocoyam	Kwahu Nsusuaa	Pumpkin	Plantain
% Yes	10	0	47.1	59.5	0	39.3	0	0	42.3
% No	90	100	52.9	40.5	100	60.7	100	100	57.7

Figure 4.27 Ready market for crops

Out of the few selected NUCS identified, a number of farmers indicated they had ready market for *Ayoyo*, Banana, Cocoyam and Plantain (47.1%, 59.5%, 39.3% and 42.3% respectively) (Figure 4.27). The farmers had middle men/women who sometimes come into the community to buy some of the crops (Figure 4.28).

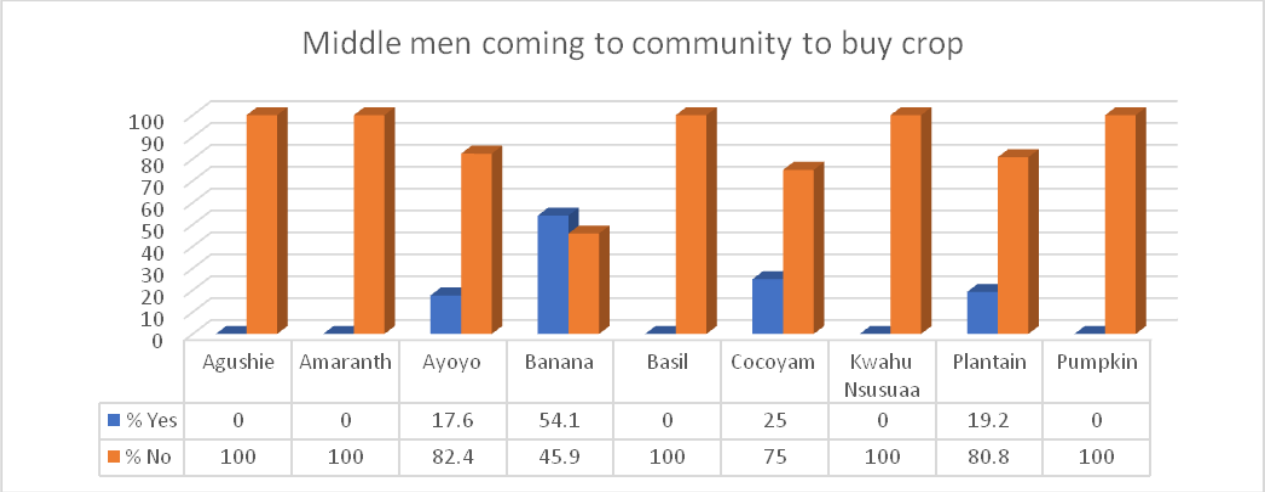


Figure 4.28 Use of middle men in the sale of the crops

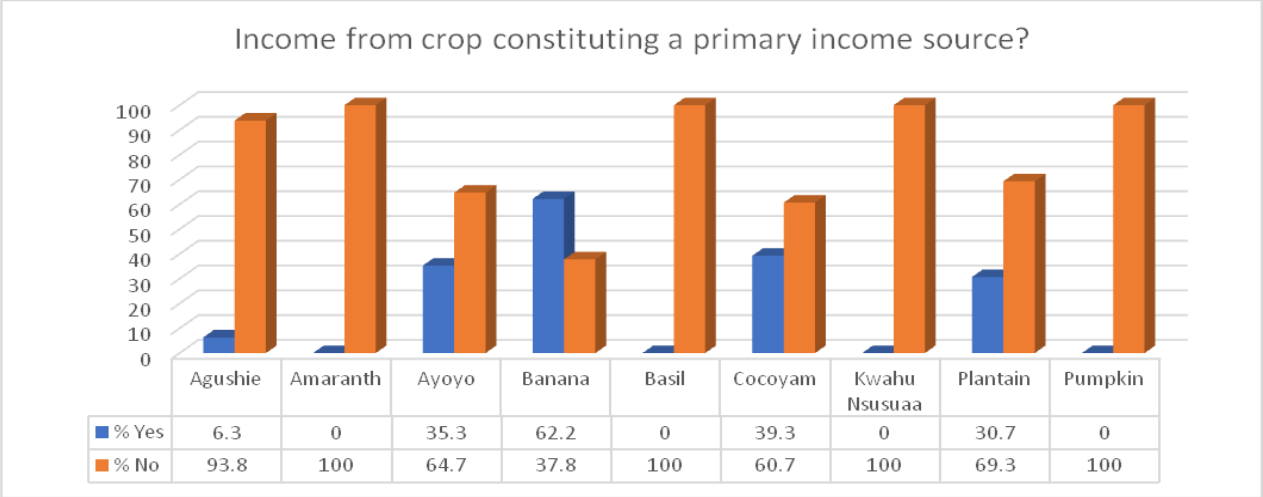


Figure 4.29 Income from crops as primary income source

From Figure 4.29 above, 6.3% for farmers who cultivated *Agushie*, (35.3%) *Ayoyo*, (62.2%) banana, (39.3%) cocoyam and 30.7% for plantain, said the income from those crops constituted a primary source of income for their households.

- *Views of traders/market women on market dynamics and NUCS*

When market women were asked to identify some specific indigenous food crop varieties that were highly patronized but presently unavailable on the Ejura and Hohoe central markets

(they fall within the two study river basins), a number of different food crop varieties were highlighted. Among the vegetables, some varieties of okro and tomatoes were identified. Okro species were available on the market during the study, however, a stripped variety known as "*tamale*" which was previously highly patronized was not readily available. A variety of tomato called *twolo*' was previously patronized but currently no longer available. It was noted that its high water and seed content makes it practically unsuitable for protracted periods of storage after harvest. This has led to their marginalization and under cultivation. Out of the different varieties of palm nuts on the market, a type known as '*bedom*' was not readily available as the other palm fruits. This variety was much more patronized due to its unique taste and quality.

Aubergines (*Solanum sp*.) were also not readily available on the market. This was attributed to their under cultivation due to low market demand. Other food crops that were previously sold but presently unavailable on the market included shallots also known as *Asante* g*yeine,* red groundnuts and bambara beans. A number of different plantain species or types available on the markets were also identified. These include '*Apantu', 'Apem', 'Odoso', 'oniaba', 'Kwakuantrowa' (nyinatia),* however, both *odoso and nyinatia* which is known to possess very 'short fingers" were not readily available. Interactions with some members of the yam sellers' association in Ejura also revealed a number of marginalized yam varieties. Among these include: *Anomasu* (since about 10 years), *Akaba, Kyirekumasi, Larborkor, Atipe, Ananka, Nananto, Krokropa, Latopa, Nkanfo.* Yam varieties such as *Nanto* and *Kyirekumasi* have not been seen or brought to the market for some years now.

4.4.2.2 Changing dietary habits and NUCS

Respondents from the focus group discussions and other key informants including a Crop Research scientist from the Crops Research Institute, Council for Scientific and Industrial

Research (CSIR) indicated that changing food consumption patterns is largely responsible for the marginalization of some local food crop varieties in the study areas. According to them when people migrate to new settlements, they lose some food crops and plant species that they used to consume at previous settlements. As a result, these food crops are not available anymore at these new settlements and therefore their children do not get the privilege of knowing and consuming these crops. Again, they grow up lacking the culinary skills that their parents and grandparents had especially in the preparation of some traditional foods such as *kamorkra* (rice meal), *akankye* (ripe plantain meal), *kamorwrewre* ("rice gari"), *apapransa* (roasted corn meal), among others.

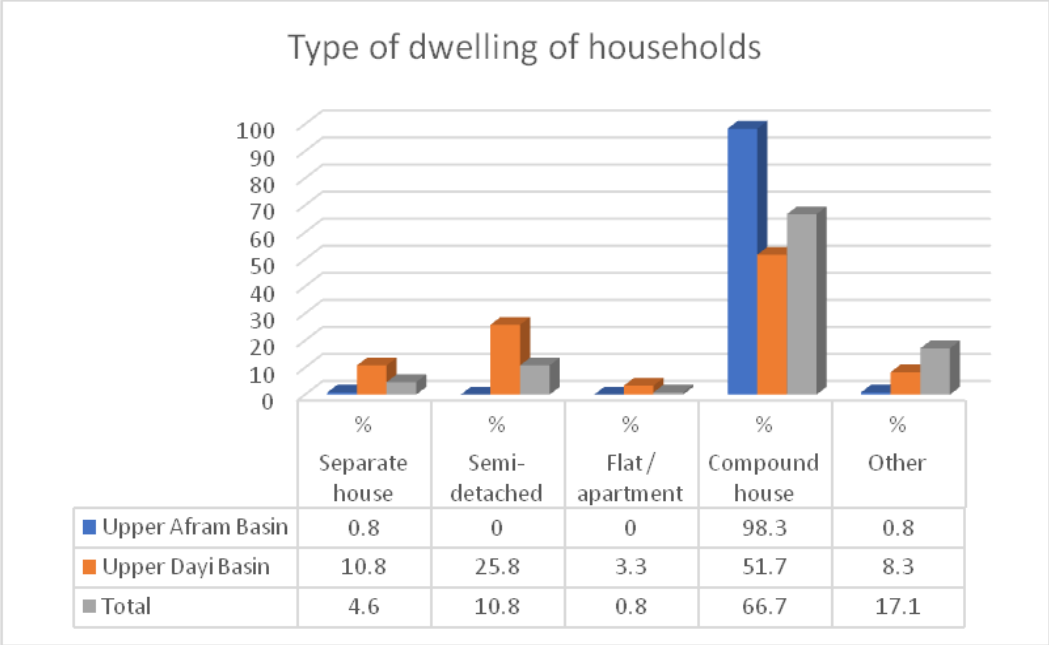
As one respondent, Mr. James Asare, a sixty-three (63) year old cocoa and rice farmer puts it "*the special way of preparing the tradional cuisines are held by the older generations who are no longer around and the younger generation do not also cook to obtain the old tradional taste hence we stop patronizing the food and the crops used in its preparation".*

4.5 Household food security and NUCS

This section presents the household characteristics and experiences of respondents on food security, NUCS and the adaptive strategies employed among rural households; within the study basins.

4.5.1 Household characteristics

Over half of the respondents in the study basins, Upper Afram (98.3%) and Upper Dayi (51.7%) occupied compound houses (Figure 4.30). Table 4.21 also showed that (70.6%) of respondents from Upper Afram and 85% from Upper Dayi were owner occupiers.



	% Separate house	% Semi-detached	% Flat / apartment	% Compound house	% Other
Upper Afram Basin	0.8	0	0	98.3	0.8
Upper Dayi Basin	10.8	25.8	3.3	51.7	8.3
Total	4.6	10.8	0.8	66.7	17.1

Figure 4.30: Percentage distribution of type of dwelling of households

Table 4.21: Occupancy status of respondents

	What is the present occupancy status?									
Name of River Basin	Owner occupied	Owner occupied	Renting	Renting	Rent-free	Rent-free	Other	Other	Total	Total
	N	%	N	%	N	%	N	%	N	%
Upper Afram Basin	84	70.6	2	1.7	29	24.4	4	3.4	119	100
Upper Dayi Basin	102	85	6	5	12	10	0	0	120	100
Total	186	77.8	8	3.3	41	17.2	4	1.7	239	100

On the ownership status of farm plots, it was found that only 37.7% of farm plots were owned by the households with deeds whilst 42.3% of farm plots were not owned by the households. The remaining 20% owned the plots but without deeds. Majority of the farm plots (51.9%) had been obtained through inheritance.

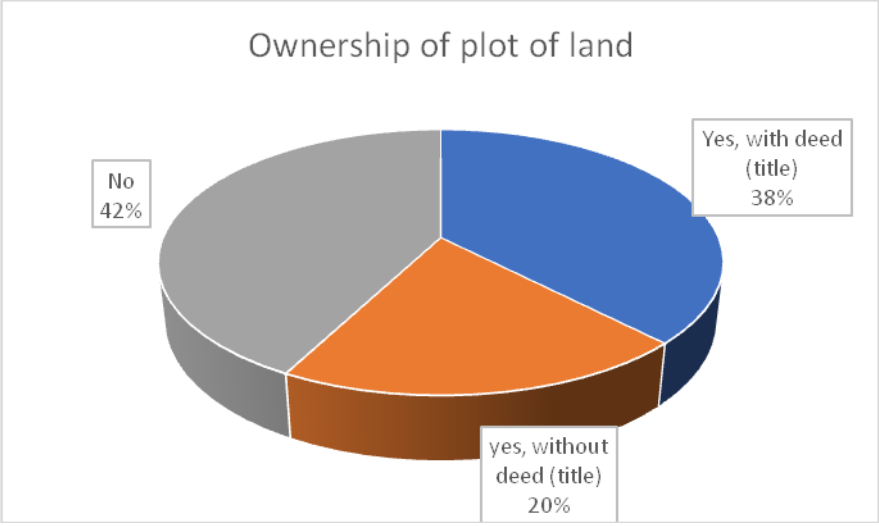


Figure 4.31 Land ownership

Figure 4.32 showed that majority (52%) of the respondents in both study basins acquired lands through inheritance whilst 22% obtained lands without charge.

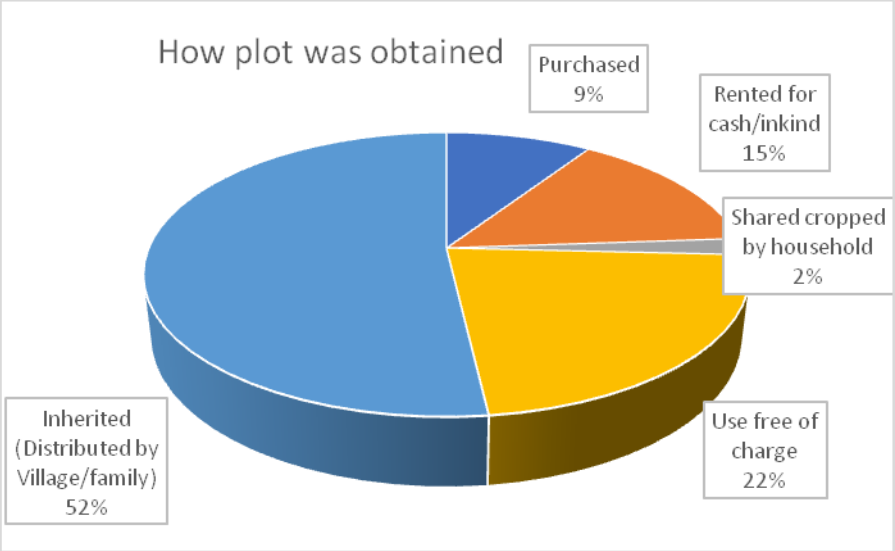


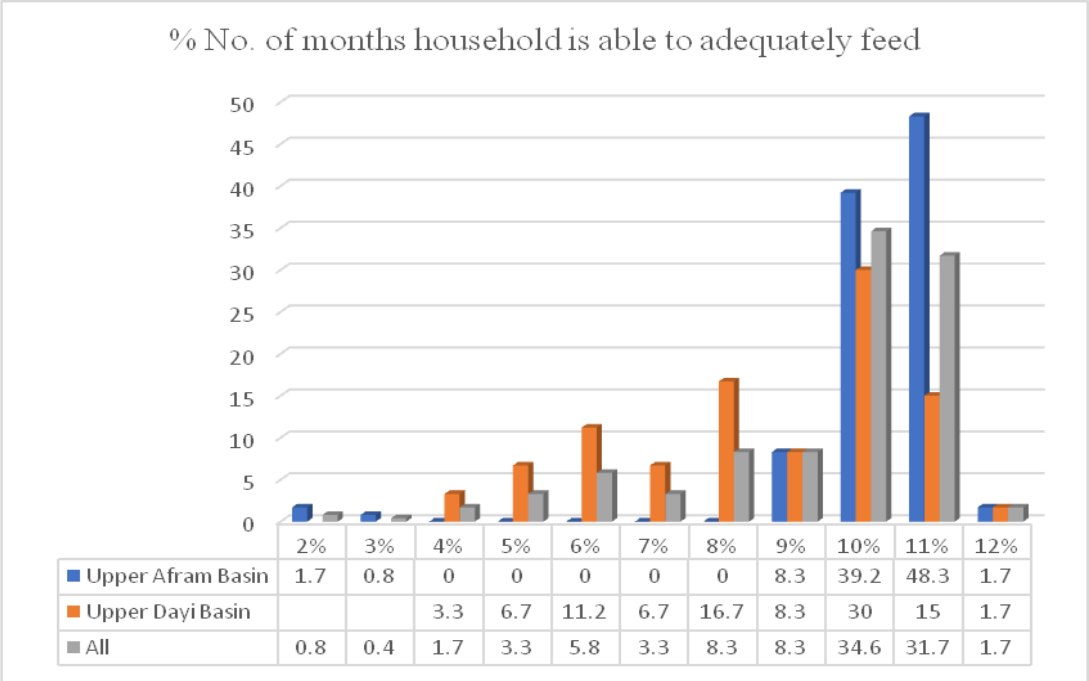
Figure 4.32. Mode of land acquisition

4.5.2 Responses on household food security and adaptive strategy

Responses on how households perceived food insecurity status of the study communities in the two study basins are presented in the following sections. The issues covered in the responses include: household's ability to feed adequately, ability to supplement household food supply, size and frequency of meals consumed by household, availability of nutritious foods for households, availability of food for a whole day, size and frequency of meals, skipped meals, availability of food for a whole day, availability of nutritious food, and reasons for inadequacy of food for households in study communities.

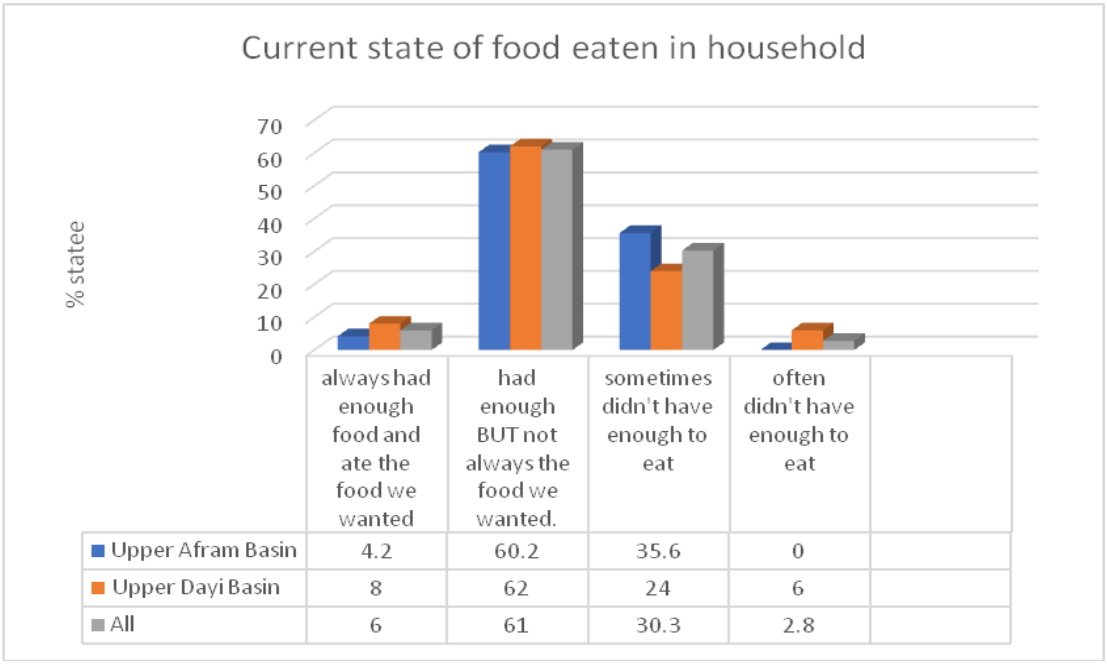
Figure 4.33 shows that majority of the farmers are able to adequately feed the household for about ten to eleven months. A greater percentage (60.2% for Upper Afram Basin and 62% for Upper Dayi Basin) also indicated that they had enough food to eat but usually not the kind of

food they wanted. This group was followed by those who ‘sometimes didn’t have enough to eat’ representing 35.6% for Upper Afram and 24% for Upper Dayi basins.



	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%
Upper Afram Basin	1.7	0.8	0	0	0	0	0	8.3	39.2	48.3	1.7
Upper Dayi Basin			3.3	6.7	11.2	6.7	16.7	8.3	30	15	1.7
All	0.8	0.4	1.7	3.3	5.8	3.3	8.3	8.3	34.6	31.7	1.7

Figure 4.33: Months in the year household is able to adequately feed itself



	always had enough food and ate the food we wanted	had enough BUT not always the food we wanted.	sometimes didn't have enough to eat	often didn't have enough to eat	
Upper Afram Basin	4.2	60.2	35.6	0	
Upper Dayi Basin	8	62	24	6	
All	6	61	30.3	2.8	

Figure 4.34: Percentage distribution of current state of food eaten by household

Table 4.22 a and b show that farmers normally buy food to supplement the household food basket in January, June, July and August. For study communities within the Upper Dayi basin, June and July were reported to be the main months whilst July and August were reported for Upper Afram basin. July is considered to be a very difficult month in terms of food provision for families.

Table 4.22a: Months of inadequate food provisioning in households within the study areas

G2. Which months in	All	Upper Afr	per Dayi Ba	Dromanko	Nokwarea	Drobon	Likpe Kuk	Lolobi Kur	Sanko Benua
	Percent of	Percent of	Percent of	Percent of	Percent of	Percent of	Percent of	Percent of	Percent of cases
January	32.3	21.43	50.9	10.53	17.5	50	60	65	23.5
February	3.2	5.1		2.63		20			
March									
April									
May	9	6.12	14.04	5.26	10		25		17.6
June	38.7	26.53	59.6	31.58	30	10	55	95	23.5
July	49.7	48.98	50.9	50	50	45	20	95	35.3
August	27.7	33.67	17.5	31.58	40	25	5	10	41.2
September	18.7	21.43	14.04	23.68	25	10		35	5.9
October	0.6	1.02			2.5				
November									
December									
Total valid cases	180	164.29	207.02	155.26	175	160	165	300	147.06

Table 4.22b: Months of inadequate food provision in study households

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dromankoma						2	1	2				
Nokwareasa						3	1	2				
Drobon	1						2	3				
Likpe Kukurantum	1				3	2						
Lolobi Kumasi	3					1	1					
Sanko Benua	3					3	2	1				
Upper Afram Basin						3	1	2				
Upper Dayi Basin	2					1	2					
All	3					2	1					

Key

1	1st month households bought food to supplement the household due to inadequacy
2	2nd month households bought food to supplement the household due to inadequacy
3	3rd month households bought food to supplement the household due to inadequacy

The period between August to December is also known to be the harvesting periods for major food crops in the middle belt (Maize: August/September and December/January; Yam: August/December; Rice: September/October; Sorghum/Millet: October/November).

The size and frequency of meals consumed by households in the study basins are presented in Figures 4.35a and 4.35b. Ascertaining whether members of the households cut the size of meals or skipped meals in the last 12 months gives an indication of the insufficiency of food among the households.

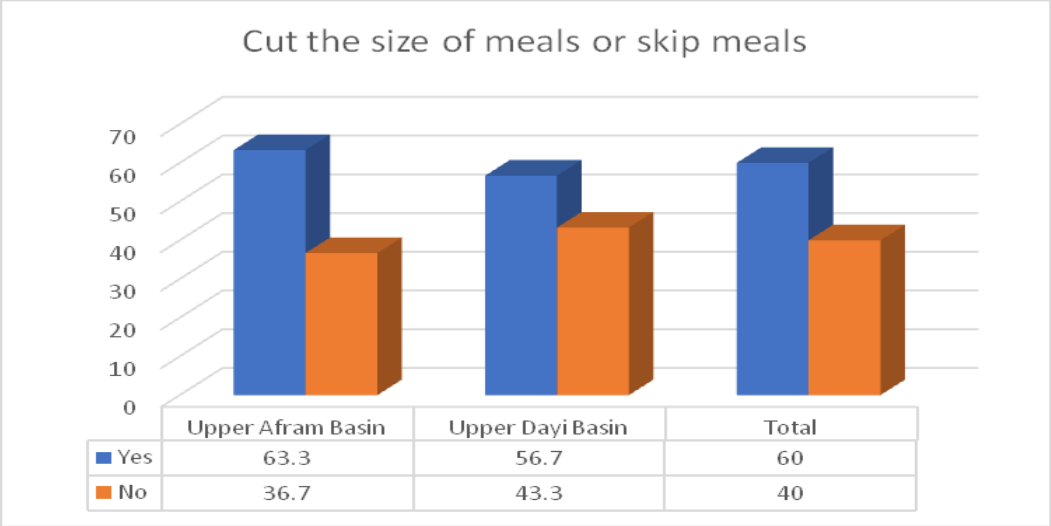


Figure 4.35a: Percentage distribution of cutting meals consumed by household

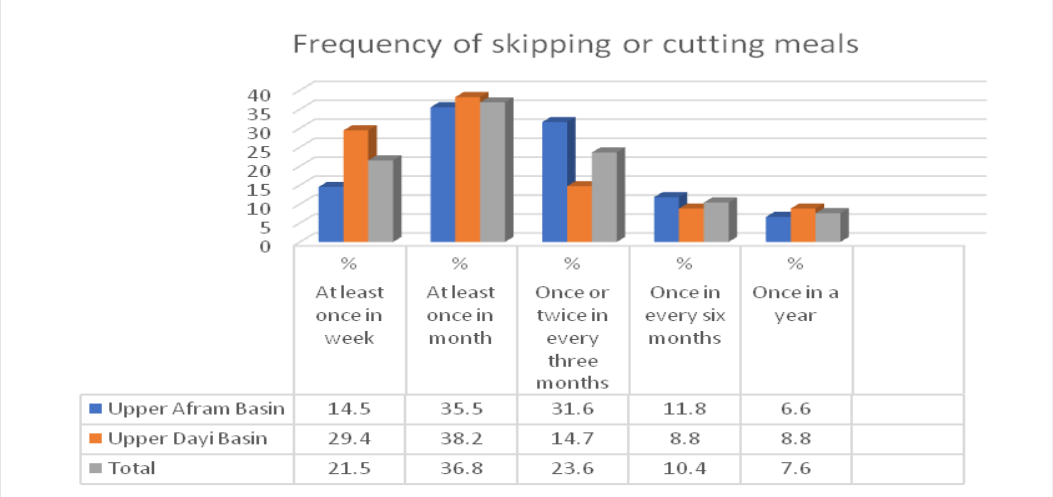


Figure 4.35b: Percentage distribution of frequency of cutting or skipping meals

The results showed that a majority of adults in households in both Upper Afram (63.3%) and Upper Dayi (56.75%) basins either cut or skipped meals (Figure 4.35a). In Upper Afram Basin, 36% of respondents indicated that households either cut or skipped meals at least once in a month while over 14% said households skipped meals at least once in a week. Respondents in Upper Dayi Basin also indicated that 38% of households also cut or skipped meals at least once in a month (Figure 4.35b).

Figure 4.36a shows the percentage consumption of nutritious food among households in the study basins. The frequency of consumption is also presented in Figure 4.36b. Examining whether household members ever consumed food that they deemed less nutritious in the last 12 months gives an indication of the nutritional security among the households. The study results showed that over 80% of households in Upper Afram Basin indicated they consumed less nutritious meals.

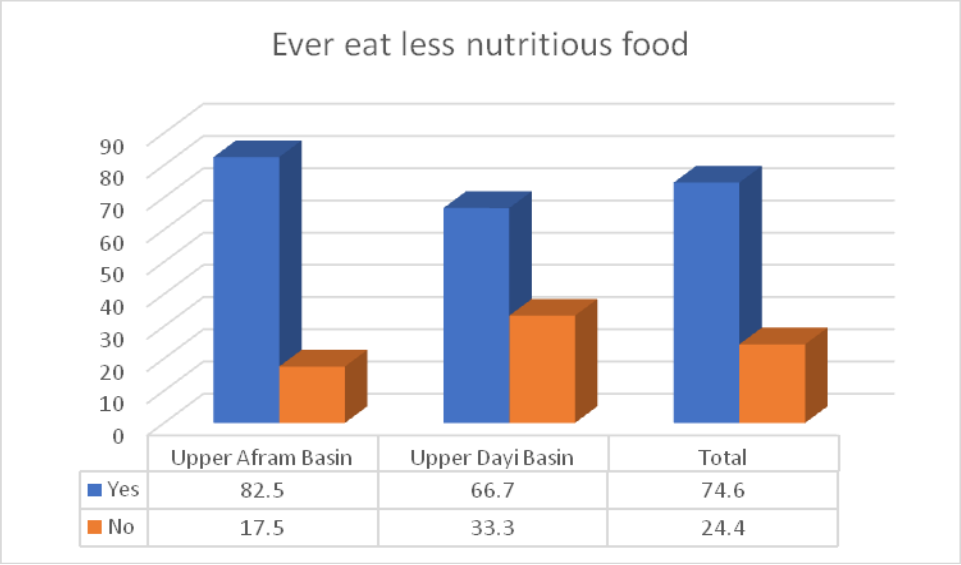
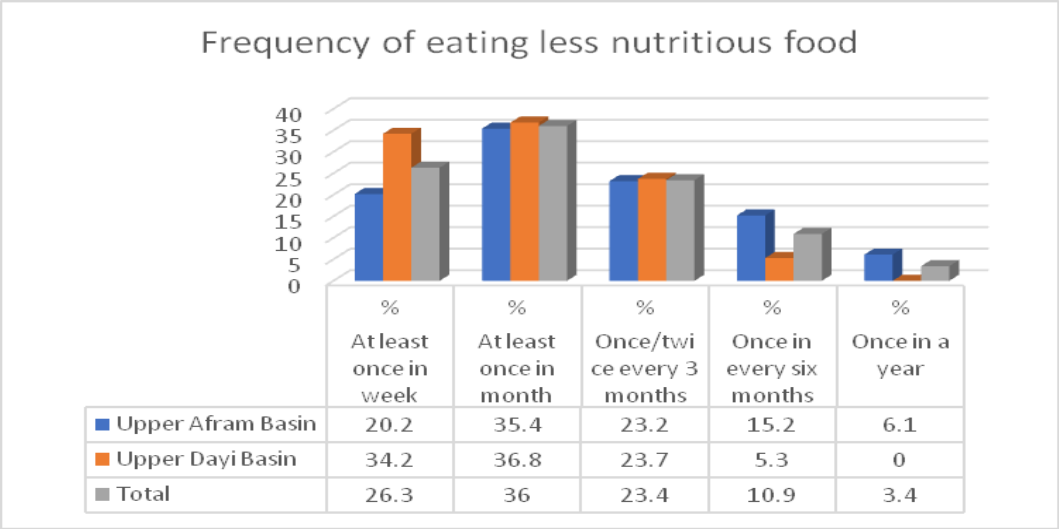


Figure 4.36a: Percentage distribution of consumption of nutritious food by households

Figure 4.36a also shows that over sixty percent (66.7%) of households in Upper Dayi basin indicated that the meals they consumed were less nutritious. In terms of the frequency of

occurrence in Upper Afram basin, Figure 4.36b shows that 35% indicated that households ate less nutritious meals at least once in a month while 23% indicated that households consumed less nutritious foods once or twice every 3 months. Thirty six percent of respondents in Upper Dayi basin on the other hand indicated that most households consumed less nutritious meals at least once in a month while 34% indicated once in a week.



	% At least once in week	% At least once in month	% Once/twice every 3 months	% Once in every six months	% Once in a year
Upper Afram Basin	20.2	35.4	23.2	15.2	6.1
Upper Dayi Basin	34.2	36.8	23.7	5.3	0
Total	26.3	36	23.4	10.9	3.4

Figure 4.36b: Percentage distribution of frequency of consumption of less nutritious food

Availability of food for households for a whole day was also assessed to ascertain whether household members never ate for a whole day. Figure 4.37a shows the percentage availability of food for households for a whole day in the study basins.

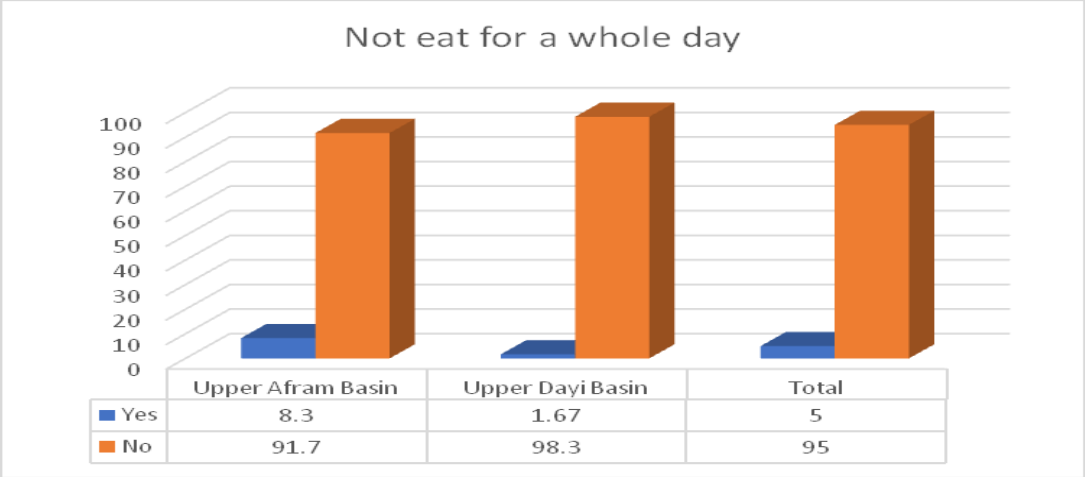


Figure 4.37a: Percentage distribution of unavailability of food for a whole day by households

From figure 4.37a only 8% and 2% of respondents in Upper Afram and Upper Dayi basins respectively indicated that they did not eat for a whole day. Figure 4.37b gives the percentage distribution of no access to food within a day in study communities in the Upper Afram basin.

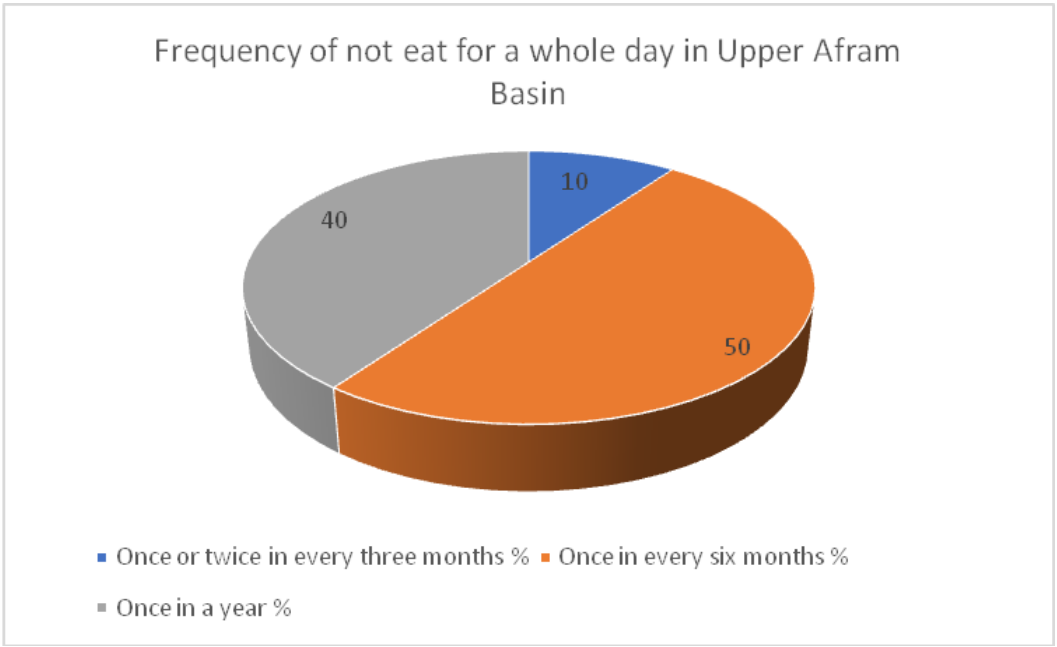


Figure 4.37b: Percentage distribution of unavailability of food for a whole day in UAB

The size and frequency of children's meal in the households in the study communities in the two basins are presented in figures 4.38a and 4.38b. Fifty percent of the respondents in Upper Afram basin indicated a cut in size of the meals of children in households with only 23% in Upper Dayi basin indicating a cut in children's meal.

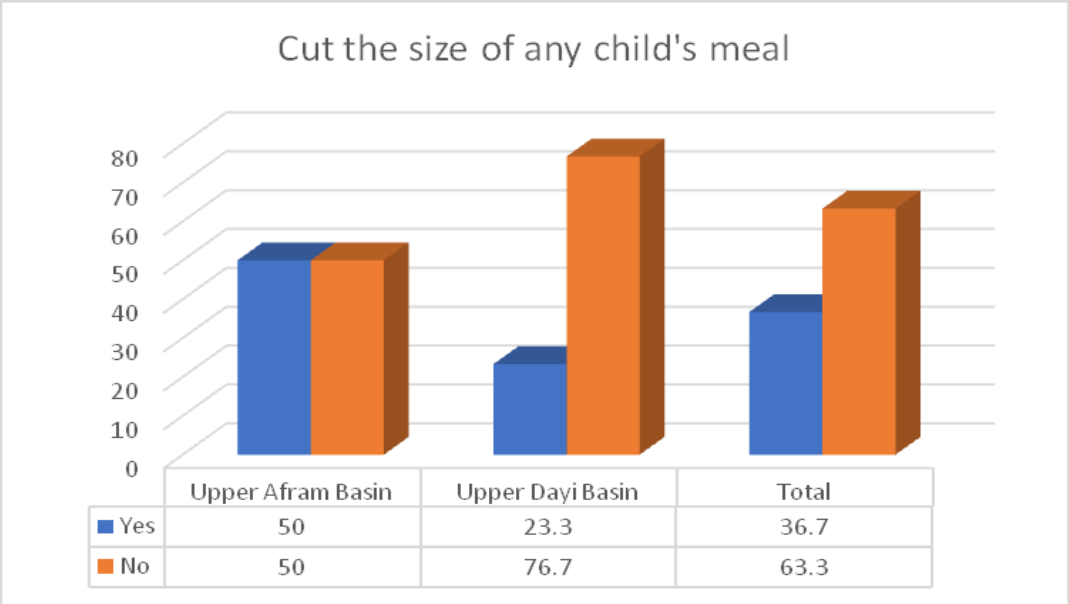


Figure 4.38a: Percentage distribution of cutting size of child's meal by households

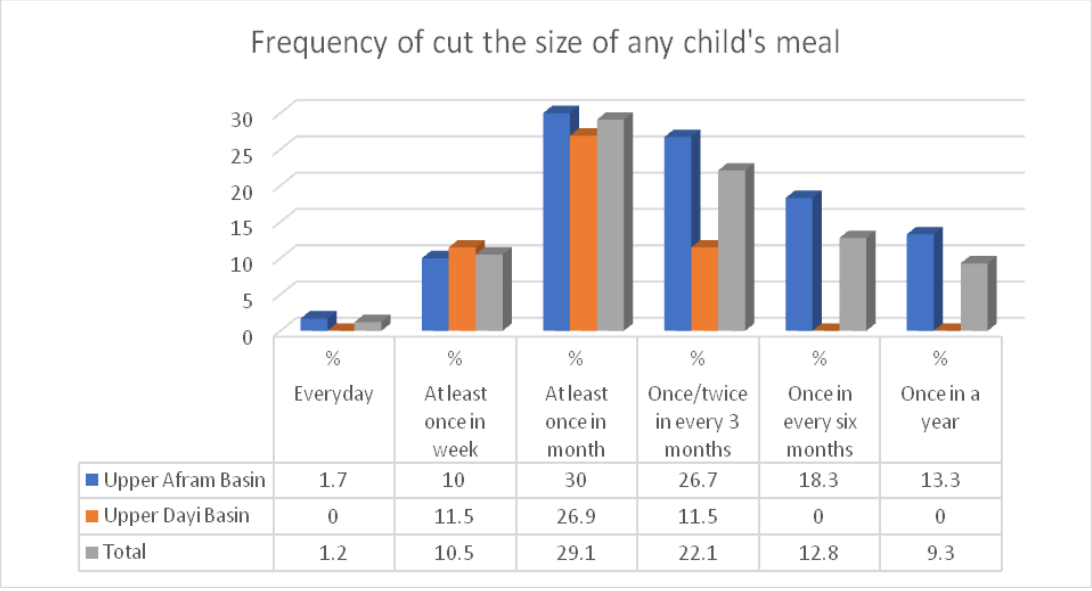


Figure 4.38b: Percentage distribution of frequency of cutting size of child's meal

Results of percentage distribution of skipped meals among children are presented in figures 4.39a and 4.39b. When asked whether children in the households ever skipped meals, over eighty percent of respondents in both Upper Afram and Upper Dayi basins indicated that children did not skip meals (Figure 4.39a).

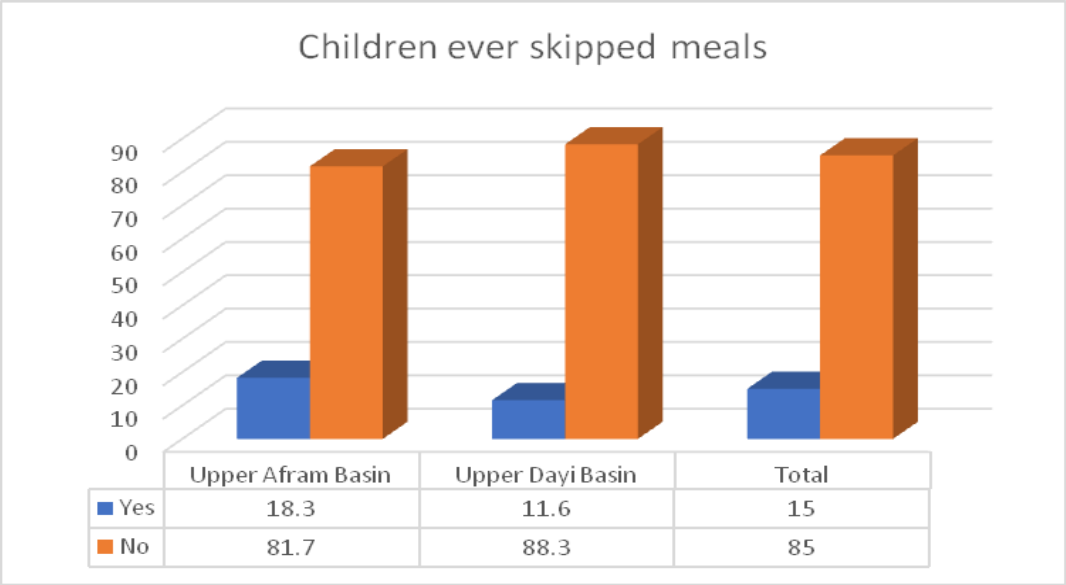


Figure 4.39a: Percentage distribution of skipped meals by children in households

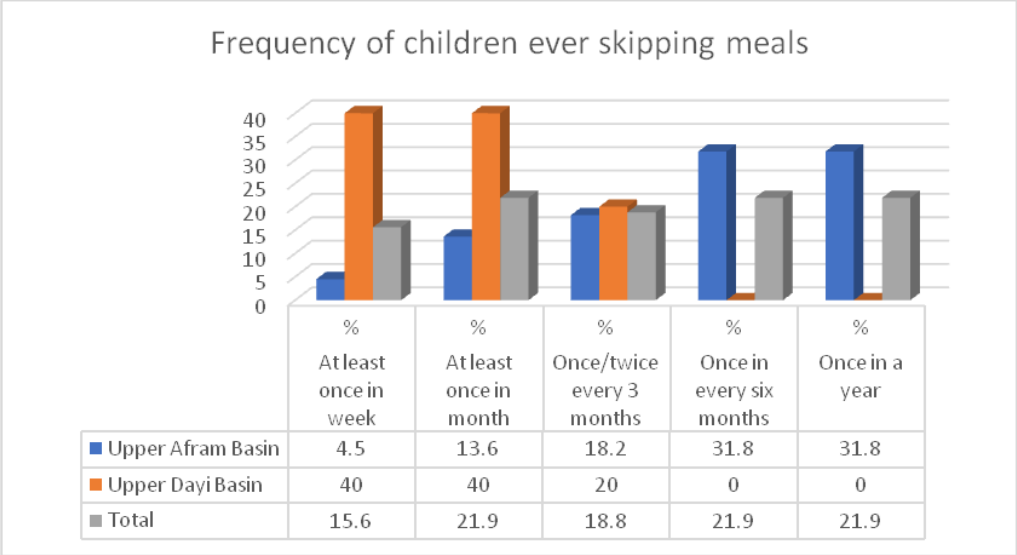


Figure 4.39b: Percentage distribution of frequency of skipped meals by children

Percentage distribution of availability of food to children for a whole day is presented in Figure 4.40. The results generally showed that though children in both study basins skip meals, they do not stay throughout the day without a meal.

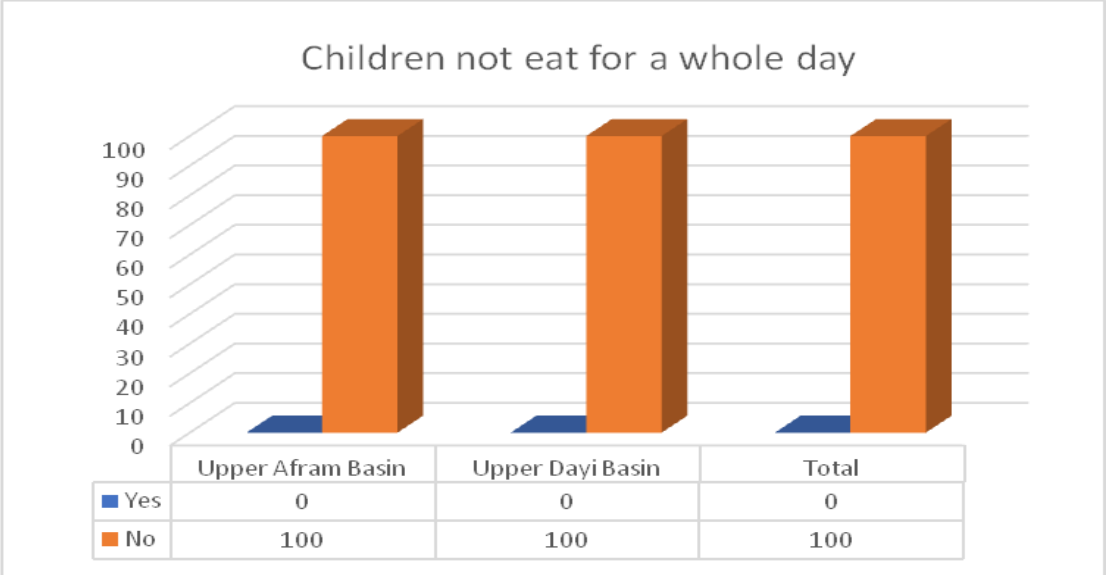


Figure 4.40.: Percentage unavailability of food for children a whole day by households

This probably may be due to the fact that in event of insufficient food for households the adults sacrificed and ensured children were fed.

Results on availability and consumption of nutritious food by children in the study basins are presented in figures 4.41a and 4.41b. Eighty-two percent of respondents in the Upper Afram basin indicated that children ate less nutritious food whilst Upper Dayi basin recorded 50%.

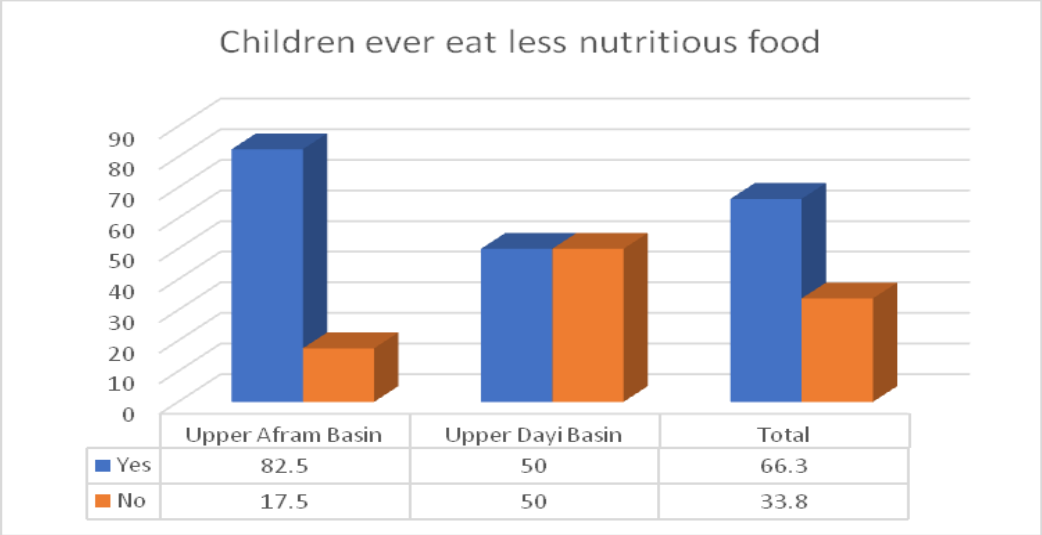


Figure 4.41a: Percentage distribution of availability of nutritious food for children by households

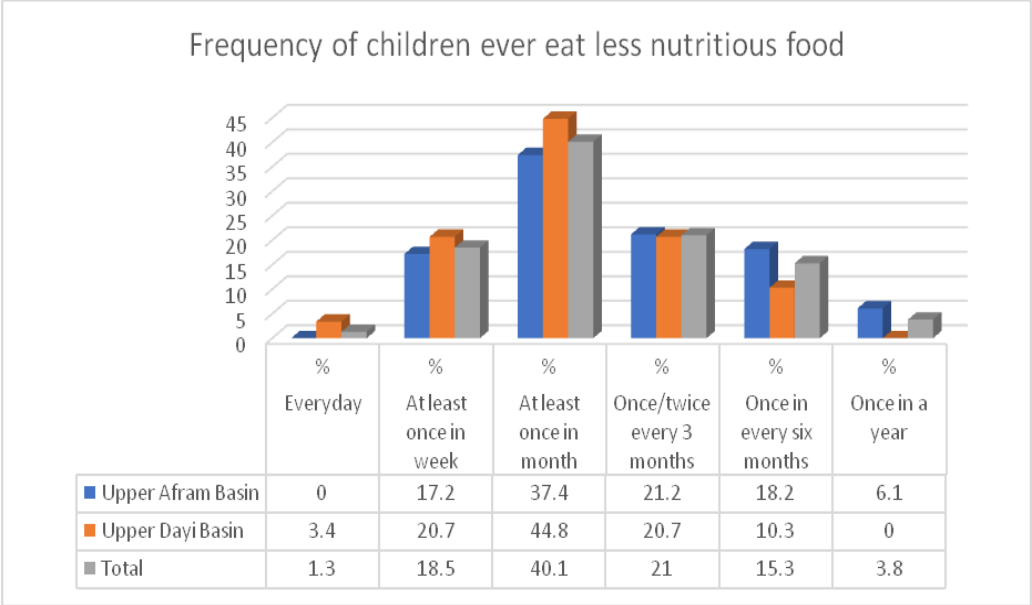
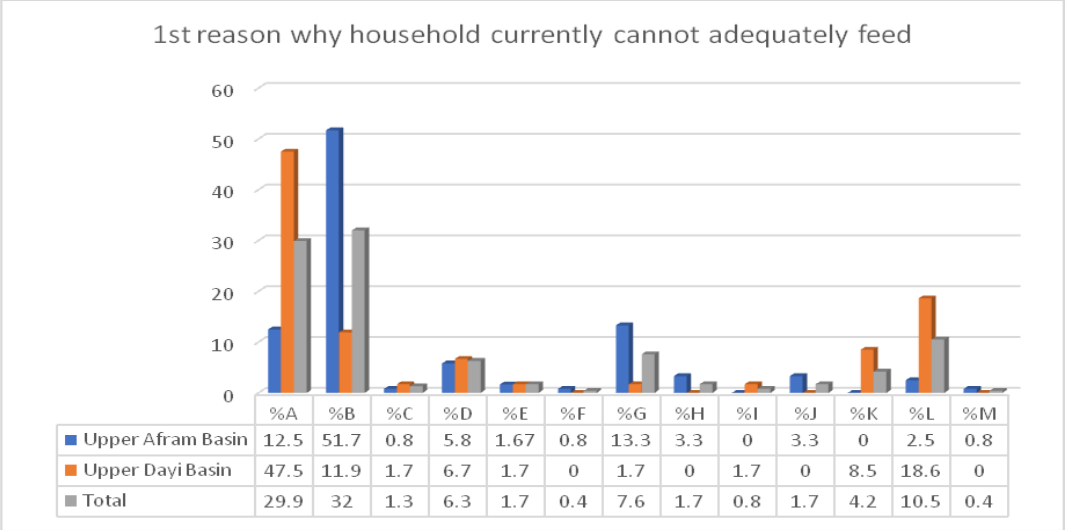


Figure 4.41b: Percentage distribution of frequency of consumption of less nutritious food by children

A number of reasons were given by respondents for the inability of households to adequately feed throughout the year. In Upper Afram basin, 51.7% of respondents indicated 'crops damage due to pests or diseases' as the first reason for inadequate food supply for feeding in the household whilst 47.5% of respondents in Upper Dayi basin indicated drought as the first reason (Figure 4.42a).

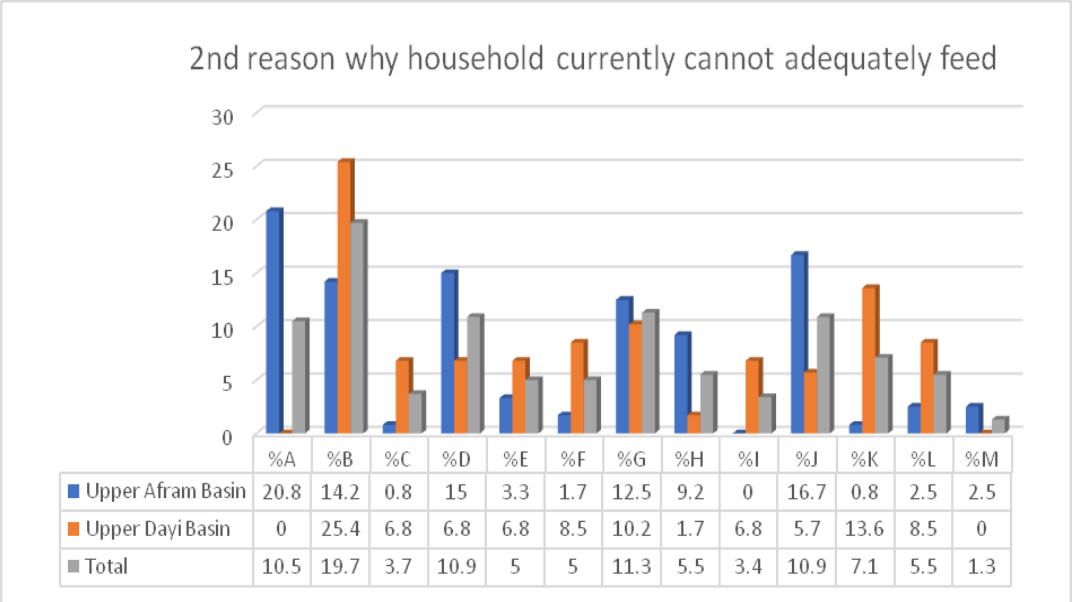


	%A	%B	%C	%D	%E	%F	%G	%H	%I	%J	%K	%L	%M
Upper Afram Basin	12.5	51.7	0.8	5.8	1.67	0.8	13.3	3.3	0	3.3	0	2.5	0.8
Upper Dayi Basin	47.5	11.9	1.7	6.7	1.7	0	1.7	0	1.7	0	8.5	18.6	0
Total	29.9	32	1.3	6.3	1.7	0.4	7.6	1.7	0.8	1.7	4.2	10.5	0.4

Figure 4.42a: First major reasons for inadequacy of food in households

Key (for Figures 4.42a and 4.42b):

A. Drought
B. Crops damage due to pests or diseases
C. Small farm size due to inadequate access to farmland
D. Small farm size due to inability to acquire adequate fertilizer
E. Small farm size due to inability to acquire adequate labour
F. Small farm size due to inability to acquire adequate other inputs
G. Poor yield due to poor soil
H. Poor yield due to poor seeds
I. Loss of crops due to excessive rain/flooding
J. Loss of crop due to bushfires
K. Inability to purchase food to supplement own production
L. Sold most of the harvest to meet other household needs
M. Other (specify) …….



	%A	%B	%C	%D	%E	%F	%G	%H	%I	%J	%K	%L	%M
Upper Afram Basin	20.8	14.2	0.8	15	3.3	1.7	12.5	9.2	0	16.7	0.8	2.5	2.5
Upper Dayi Basin	0	25.4	6.8	6.8	6.8	8.5	10.2	1.7	6.8	5.7	13.6	8.5	0
Total	10.5	19.7	3.7	10.9	5	5	11.3	5.5	3.4	10.9	7.1	5.5	1.3

Figure 4.42b: Second reasons for inadequacy of food in households

Crop damage due to pests and diseases recorded the highest score of 32% among respondents in both study areas (Figure 4.42a). Drought is another major reason given by respondents in communities in the Upper Dayi basin (Figure 4.42a) often leading to low productivity with adverse effect on household food security. Interaction with the farmers during the study also pointed to increased frustration and complaints due to the increased loss of vegetative cover especially trees in the river basins.

The second major reason given by all respondents (from both study basins) for inadequate food in the households was crop damage due to pests and diseases (Figure 4.42b). The third identified major reason is poor yield due to poor soil.

CHAPTER FIVE

DISCUSSION

5.0 Introduction

This chapter analyses and discusses the implications of the study findings. A framework for discussing the findings in Figure 5.1 is used to present and discuss the linkages between the various findings. The discussion is presented in two parts. The chapter starts by presenting the socio-economic background of the respondents; the identified NUCS and their uses; the pevailing agricultural practices, the environmental and socio-economic factors influencing NUCS cultivation, and the possible implications for household food security in the Upper Afram and Upper Dayi basins. The chapter concludes with a general discussion on the linkages between the study findings and the Resource based theory, the study propositions, the Sustainable Development Goals (SDGs) and the agriculture and food policy framework.

5.1 Socio-economic background of respondents

Farmers' demographic characteristics such as age, household size, level of formal education, size of farm, experience in farming among others, are known to influence agricultural production (McCulloch & Ota, 2002). The gender distribution of respondents in the study communities in Upper Afram basin agreed with the trend of 50.2% males and 49.8% females in the 2010 Population and Housing Census (GSS, 2014a). The observed trend in Upper Dayi basin study area however contrasts the gender distribution of 52.1% females and 47.9% males for the Hohoe municipality (GSS, 2014b). The high percentage of male respondents in

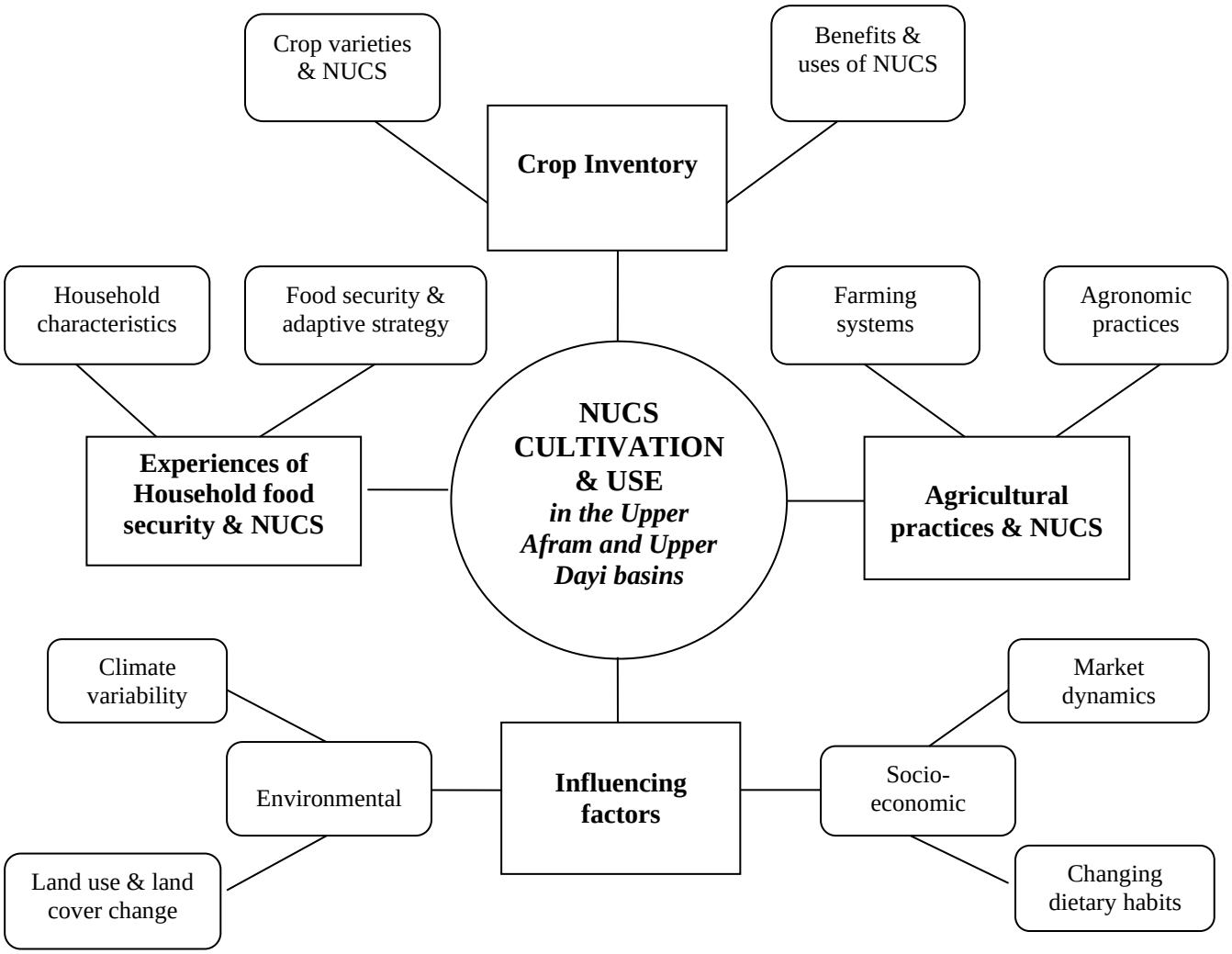


Figure 5.1: Framework for discussion of the study findings

both study areas, from the study, generally gives an indication of the dominance of male farmers in farming activities in the study areas as compared to the female farmers. Women and children especially from female headed households have also been known in other jurisdiction to be engaged in farming activities while their men migrated from their local communities in search of other jobs.

With respect to age of respondents, researchers such as Genius *et al.* (2006) have suggested a reasonable linkage between age and farming experience. This relationship is also confirmed

by Nkari and Kibera (2016). The older generation of farmers engaged in the study appeared more informed and possessed the relevant indigenous knowledge through their continuous engagement with the local environment even though increased length of years generally does not always imply increased knowledge and experience. They had a better appreciation of the importance and use of the indigenous food crop varieties and species that have now become marginalized or neglected as compared to the younger farmers. It must however be noted that the results did not necessarily imply a lack of interest or low participation of the younger generation in any farming activities.

Majority of the farmers interviewd during the study were found to be engaged in one form of marriage relationship or the other. This suggests that a greater number of the farms were owned by families or heads of households. Regarding the ownership of farmlands only 37.7% of farm plots were owned by the households with deeds whiles 42.3% of farm plots were not owned by the households. The remaining 20% owned the plots but without deeds while majority of the farm plots (51.9%) had been obtained through inheritance.

Low level of education was generally observed among the farmers engaged during the study. Farmer educational status is important due to its potential influence on the success of their farming enterprise. A more informed or educated individual invariably possesses an advantage over the less educated. Another important quality in addition to being informed or educated is the willingness to adjust to changes and for the farmer adjusting to new technological changes in order to increase production. The generally low levels of education observed among the farmers engaged have implications for the level and impact of farming activities in the study areas.

Famers in the study communities comprised both indigenes and settlers. Majority of the respondents in the Upper Afram basin were typical Akans with a few farmers of northern descent whilst those of Upper Dayi were mainly Guans with a few Ewes.

5.2 Crop varieties and NUCS

Neglected and Underutilized Crop Species (NUCS) constitutes an integral part of agrobiodiversity and are known to occur widely in various forms both in temperate and tropical areas (Padulosi *et al.,* 2013) including Ghana. Studies on agrobiodiversity and NUCS in Ghana have confirmed the diverse nature and usefulness of these crops in various parts of the country. The findings of this study in Central Ghana which recorded a total of one hundred and twelve (112) NUCS in both Upper Afram and Upper Dayi basins further confirm this diversity. The observed NUCS diversity could be attributed to the rich agrobiodiversity of the semi-deciduous rainforest and the forest savannah transition zones within which the study was carried out. This rich diversity has also been reported by Nyadanu *et al.* (2015) who examined the NUCS diversity among other things in some selected farming towns located within the coastal, forest, transitional and guinea savanna zones of Ghana. The high numbers of NUCS identified in the study areas presents the agricultural sector with the opportunity to consider widening the national food basket to include NUCS especially given their known contribution to food security among indigenous communities.

The findings of the NUCS inventory survey further show that several species of indigenous food crop varieties in central Ghana are currently under cultivated, marginalized and neglected due to some identifiable causes. The marginalization and erosion of over twenty yam species recorded in the study communities in Upper Afram basin is a source of concern as yam is a commonly cultivated food crop in the area. This incidence of serious genetic erosion of yams is also corroborated by Aboagye *et al.*, 2015. Yam is regarded as one of the

few important staple crops in Ghana. It plays an important role in the cultural rites (such as yam festivals) of the people of Ghana. Yam also referred to as "King of Crops" in Nigeria contributes substantially to household food security (Kenyon & Fowler, 2000). Yam is also known to provide a wide variety of dishes that are boiled, roasted or fried. Depending on the variety it could be used for *ampesi* (boiled starchy staple served with stew or sauce), *ɔtɔ* (mashed yam), *fufu* (pounded yam), yam balls, porridge or fried yam chips. The erosion of yam varieties therefore may lead to loss of cultural identity of some tribal groups, change of favourite staples among others.

- Uses and benefits

Many NUCS historically have been known to provide several benefits and uses. These indigenous crops have served as dietary support to many rural households and communities (Chivenge *et al.*, 2015). The study also revealed that some indigenous rice species in the Upper Dayi basin are currently underutilized and neglected. This observation could have adverse implications as rice was found to be the commonly grown food crop among farmers in the study communities. Additionally, rice is also regarded as one of the country's key staple crops. Asante *et al*. (2013) confirms that in recent years, rice has become an important staple food in Ghana. Rice is easy to cook and gives options for a wide variety of dishes. It possesses both nutritional and medicinal properties such as protecting the body against constipation (Olembo, M'mboyi & Oyugi, 2010). Indigenous rice is also known for its socio-cultural values as it plays a major role in religious rites, festivals and other ceremonies such as wedding rites for the people of Likpe and Lolobi of Upper Dayi basin. It is also used for preparing baby foods, soups and brewing purposes (Olembo, M'mboyi & Oyugi, 2010).The study findings showed that NUCS were used as source of food, medicine, dye and soap making, fuel wood, livestock feed among others in the study areas. The performance of some

traditional ceremonies and activities such as the outdooring and installation of chiefs, funerals, marriage ceremonies in study communities in the Upper Afram and Upper Dayi basins are associated with NUCS. This is corroborated by IPGRI (2002) and Padulosi *et al.* (2013) who assert that NUCS represents an intimate part of local cultures and traditions.

The cultivation and use of these indigenous crop varieties however has been constrained by several factors. Among the key factors inhibiting the cultivation of NUCS in the study areas include labour-intensive and time-consuming methods of cultivation and low productivity. These observations agree with a report by Dansi *et al*. (2012) who also identified low yield and laborious production as some of the causative factors responsible for the underutilization of these indigenous crop varieties. A study by Assogba *et al.* (2015) also highlights high labour requirement as the third ranked reason for decreasing cultivation of *Macrotyloma geocarpum*, a marginalized crop variety. Other studies have also highlighted factors such as impact of market forces; abuse of pesticides and other agrochemicals; climate change impact; loss of traditional knowledge of indigenous crops; lack of appropriate legal framework and changes in land use (FAO, 2010).

5.3 Agricultural practices and NUCS

- Farming systems

Traditional farmers have over the years employed various farming and agronomic practices in the cultivation of their food crops. The study revealed that both study areas in the past practiced traditional agro forestry and employed the traditional cropping systems: mixed cropping and monocropping. The traditional cropping system particularly mixed cropping allowed farmers to cultivate many indigenous food crop varieties. In India NUCS are cultivated mainly as mixed or intercrop with fodder yielding cereals such as sorghum, grain

legumes among others (Bala Ravi *et al.* 2010). Mabhaudhi *et al*. (2016) also argues that NUCS by their diverse nature employ different farming or cropping systems, through intercropping or crop rotation. In Southern Africa NUCS are found in cropping systems across the entire major agro–ecological zones. Farmers in Upper Afram and Upper Dayi basins in the past engaged in similar traditional agronomic practices which involved land preparation, sowing, weed and pest control, soil enhancement, watering, harvesting, and storage. Farmers employed traditional farming practices even though many of these practices have changed or evolved over time.

The presence of large commercial farms as observed in Upper Afram basin could be responsible for the improved methods of crop production in the area. The use of simple implements for land clearing has been replaced largely by the application of agrochemicals such as total herbicides and tractor ploughing particularly in Upper Afram basin. Mechanized farming which involved tractor ploughing was found to be relatively prominent on large commercial farms in Upper Afram basin as compared to the study communities in Upper Dayi basin. It was also observed that tractor ploughing seemed to be efficient, however its adverse effects on the cultivation of some food crops such as yam were a source of concern. Yam cultivation normally requires the presence of trees which serve as stakes. These stakes get destroyed during the ploughing process which further creates ridges on the land leading to soil erosion. Harrowing, a process that involves the loosening of the soil left after ploughing is the common way of addressing the problems (ridges leading to soil erosion) created by the ploughing process. However, most farmers are not able to bear the cost of harrowing and are therefore compelled to plant on the ridges, a situation that leads to the reduction of the quantity of seeds that are cultivated per a farm land thereby affecting yields. Officials from

MoFA have attributed the situation to the inexperience of most tractor operators and therefore provide training workshops to equip the tractor operators with the requisite skills.

- Agronomic practices

The practice of agriculture and the manner in which farmers engaged in crop cultivation have changed with time. In earlier years, farming was basically for subsistence needs. Cultivation of small farm lands therefore required very simple implements such as hand hoes and cutlasses. Due to the practices of small farm cultivation with very low human populations at the time; virgin lands were abundant and the soils were also fertile because they had not been exhausted with year to year cultivation. As farming systems have evolved over the years, so has its influence over farm lands. In earlier years, abundant farm lands were available due to the low human population. Households therefore did not purchase farm lands. These farm lands were also close to their places of residence. Josephson, Ricker-Gilbert and Florax (2014) highlight this relationship between population and size of farmlands in a study on how population density influences agricultural intensification. The study reported that higher rural population density leads to smaller farm sizes.

Agronomic and farm management practices are essential to agricultural production as they contribute to increase in crop yield. Agronomic practices therefore can influence the promotion or under cultivation of some indigenous crop varieties. This study identified among others, three major agronomic factors namely: low productivity, limited water and time-consuming methods of cultivation as the factors that may be influencing the under cultivation or marginalization of some local food crop varieties in the study communities. Dansi *et al*. (2012) in a related study on the causes of underutilization of some indigenous crop species in the tropics, specifically in Benin, also highlights agronomic factors such as

low yield; laborious production; lack of improved cultural practices and varieties; as well as susceptibility to pests and diseases.

- Agrochemical use and agricultural production

The use of agrochemical to boost agricultural production is widely acknowledged as it guarantees and enhances agricultural productivity (Omari, 2014). Due to the extensive use of agrochemicals in weed control the practice of mulching has reduced considerably meanwhile the practice helped to conserve soil moisture, regulate soil temperature, prevents erosion, suppresses weed growth, improves soil condition and increases soil fertility (Sharma and Bhardwaj, 2017).

In Ghana, agrochemical abuse among farmers, particularly pesticides, remain a major source of concern given the attendant adverse effects on human health and the environment (Asante & Ntow, 2009). Application of agrochemicals on harvested food crops for the purposes of preservation is a common practice in most parts of the country including the study areas. Reports from MoFA (2015) indicate a steady increase in the incidence of agrochemical (fertilizers and pesticides) imports over the years (2006 to 2015). Even though exact figures on the quantities of agrochemical usage in the two river basins are not readily available, the widespread abuse among the local farmers was confirmed during interviews with the local farmers and the Ministry of food and Agriculture (MoFA) agricultural extension officers in the study communities. Agrochemical use has also limited the practice of intercropping. Some of the agrochemicals especially the weedicides are not selective and therefore their application lead to the destruction of both weeds and crops.

Responses from the farmers during the focus group discussions also indicate that the use of ashes as a form of "insecticide" for the cultivation of food crops such as okro and beans has

been replaced by insecticide use including even Dichlorodiphenyltrichloroethane (DDT) which is officially banned in Ghana. Neem was used as an insecticide, whiles chicken droppings served as fertilizers. These forms of "natural insecticides" according to the farmers are no more in use due to the need to secure relatively large farm produce from pest invasion and destruction.

Agrochemical use is currently a predominant agronomic practice in the communities studied despite their adverse health effects when improperly used. This observation is a worrying concern given the known health implications for the farmers. The high incidence of agrochemical abuse among the farmers in the two basins could be attributed probably in part to lack of adequate sensitization on the use and negative health implications as well as, the observed low level of education among farmers in the study areas as shown in the farmer demographics in Table 4.1. According to the results, (29.2%) of farmers within the study communities in the Upper Afram basin had completed primary education while majority (less than 50%) of farmers in the Upper Dayi basin had some secondary education. The farmers probably are unable to read labels on the chemical containers before use and for those who are able to read, comprehension or understanding may be a challenge and therefore are unable to follow the prescribed protocols for efficient use.

The phenomenon of agrochemical abuse as observed in this study in the two basins particularly Upper Afram is corroborated by Mabe *et al*. (2017) in a similar investigation that examined the health effects of agrochemical use and its impact on maize production in the Ejura-Sekyedumase municipality. The study observed that respondents were only moderately aware of the health implications of agrochemical use. Mabe *et al*. (2017) further showed that awareness of health implications of agrochemical use significantly increases maize output. The observation that low level of education may be responsible for the current agrochemical

abuse in the two study areas is also confirmed by Omari (2014) in a survey on farmer knowledge on the effects of agrochemical use on human health and the environment in the Akuapem South municipality. The study revealed that farmers failed to read chemical labels probably due to their inability to read.

- Agrochemical use and NUCS cultivation

Several studies have highlighted the negative effects of agrochemicals on crop production and the environment (Table 4.7). Among these include the threat to biodiversity, destruction of wild to semi-natural habitats and the disruption of functional soil structures and pollination services (PAN, 2017); the introduction of foreign weeds, which rather deplete the soils of moisture and nutrient (Baishya, 2015), the weeds grow faster and compete for available nutrients, water, space and sunlight; and the acidification of soil which affects most crops due to continuous application and significant variations in the populations of soil microorganisms (Ogbodo & Onwa, 2013). Traditional agronomic practices that were employed by the local farmers in the Upper Afram and Upper Dayi basins have been heavily affected with the introduction of agrochemical use, a situation that has also affected the practice of intercropping and mix cropping which were employed by farmers in the cultivation of a wide range of indigenous crop varieties.

Responses elicited from interviews with the local farmers, MoFA officials and agricultural research officers in the study areas have all pointed to the high agrochemical abuse as the key agronomic factor that may be responsible for the observed marginalization of some of these indigenous food crop varieties in the study communities. The decreased cultivation or unavailability of the indigenous crop varieties that were traditionally cultivated by the local farmers in the area can therefore be attributed largely to the current high level of

agrochemical use. Some agrochemicals used on farms cleared and destroyed both farm crops and weeds thereby destroying some of the local crop varieties in the study areas.

This observation and assertion are consistent with the findings of Nyadanu *et al*. (2015) who attributed factors such as the increased use of systemic weedicides as one of the key factors responsible for the genetic erosion of NUCS in some communities including Ejura. Nyadanu *et al*. (2015) in a study that examined the management practices of NUCS and the relationship between traditional farming systems and the safety of NUCS conserved on farm in Ghana showed that weedicides for example prevent or inhibit the emergence of some useful plants such as cocoyam (*Xanthosoma sagittifolium, Colocasia esculenta*) after clearing of farm lands.

The study revealed that the application of weedicides resulted in the erosion of the NUCS. It can therefore be inferred that wild varieties of these crop varieties and plant species do not thrive in disturbed environments but are able to survive in their natural environment when traditional methods of farming and agronomic practices are employed. The effects of climate change may also have contributed to the erosion of these crops from their natural environment. Most major crops have been synthesized in one way or the other and this may be enhancing their ability to survive in disturbed environments or accommodate environmental stresses. In an attempt to deal with the issue of disturbed lands arising from the effects of environmental change such as land cover change, the farmers engage in indiscriminate use of the agrochemicals in order to enhance crop production. This often leads to excessive intake of the chemicals by the crops thereby posing health risks to consumers of these food crops. Bioaccumulation and biological magnification are some of the major issues associated with excessive pesticide use (Grewal *et al.*, 2017).

The current focus on the cultivation of a few selected staple crops in Ghana have gradually led to a marginalization and underutilisation of some of the indigenous crop varieties that characterised farming in the communities studied. Agrochemical abuse among farmers was found to be one of the major agronomic constraints influencing the cultivation of NUCS in the study basins.

5.4 Factors influencing the cultivation and use of NUCS

- Environmental factors
- Climate variability

Analysis of the climatic variability experienced within the two study basins over the 40-year period (1976 to 2016) revealed some anomalies in both temperature and rainfall patterns. The results show a changing rainfall pattern and increases in average temperatures in both Upper Afram and Upper Dayi basins. Climate change affects crop production through changes in temperature, rainfall patterns, droughts, and floods. Rainfall and temperature pattern constitute the two important indicators of climate variability, therefore changes in these two indicators reflect on agricultural yields. Studies have shown that these changes affect the quantity of water available to crops and results in salinity and aridity of soils and groundwater depletion (FAO, 2008; Bals *et al*. (2008).

In Sub Saharan Africa, climate change and variability pose a major threat to agricultural production and food security. Its impact on food crop production in many countries particularly in Africa is projected to lead to decreased agricultural yield and productivity (IPCC, 2007). Reliance on rainfed agriculture over the decades has been reported to be one of the key factors for Ghana's increased vulnerability to the impacts of climate change (Yaro, 2010). Dasgupta and Baschieri (2012) and Stanturf *et al*., (2011) among other studies have

argued that Upper East, Upper West and Northern regions constitute the vulnerable areas due to under development and arid nature of those areas. Even though the effects of climate variability may not be intense within the study basins as compared to the more arid regions of the country, observed changes in the rainfall and temperature patterns experienced in Upper Afram and Upper Dayi basins are affecting crop production as attested to by the farmers. This invariably affects crop diversity leading to possible decline in the availability of varieties of indigenous food crops in the study areas.

- Land use and land cover changes, NUCS and crop diversity

Forest cover which previously was abundant has reduced due to deforestation activities. Forest trees have been cut for construction, biomass and timber production as well as farming purposes. The results of this study have shown considerable dynamics in land-use land-cover (LULC) change from 2000 to 2018 in the study basins. There have been some remarkable changes in the LULC over the 18-year period in the study basins. The Upper Afram basin has witnessed generally high levels of LULC changes due to reasons such as the relatively higher level of mechanization associated with farming in the area. Mechanized farming which involves the use of tractor ploughing has largely influenced the practice of farming in Upper Afram basin, hence the presence of large commercial farms in the area.

Agricultural activities in the Upper Afram basin therefore may be partly responsible for the observed land cover changes in the area. Ampofo *et al*. (2015) confirms this observation and assertion in a study that examined the land cover change patterns in the Volta gorge area of the Volta basin of Ghana between 1975 and 2007. Agricultural activity was highlighted as the major cause of land cover change witnessed in the Volta Gorge area. Several other reasons have been attributed to land use and land cover changes. The present study also showed that

population increases in the study basins over the period contributed to the observed land use and land cover change in the area. This is corroborated by Ogechi and Hunja (2014) in a study that explored the impact of land use and land cover changes on food production in Kenya. Mussa *et al*. (2017) also suggests causes such as demographic, climatic as well as inadequate government policies and development interventions.

Mussa *et al*. (2017) further argues that the LULC change presents some adverse impact on the environment among which include biodiversity loss, soil degradation, bush encroachment, livestock loss, and rangeland degradation. The general decline in LULC in the Upper Afram and Upper Dayi basins has implications for agricultural biodiversity and particularly crop diversity in the two study areas. Additionally, the conversion of forests into other land use types as suggested by Lanbin and Geist (2006) may result in fewer opportunities for wild food collection. Natural habitats when destroyed through LULC change therefore leads to the loss of certain plant species. Meanwhile it is known that most NUCS are found in the wild.

- Socio-economic factors

- Market forces and NUCS

Agricultural production in recent years has been influenced by market forces leading to the current emphasis on selected key staple crops. This is generally the situation in the two study basins. The Upper Afram basin has been known historically to be a leading producer of maize and yam in the Ashanti region which makes Ejura one of the major marketing hubs in the middle belt of Ghana. Maize and yam have therefore enjoyed significant patronage from traders from different parts of the country and some neighbouring countries even though other staple crops are also grown in the area. The availability of ready markets coupled with

the introduction and use of modern inputs has made maize cultivation very profitable in Upper Afram Basin. The presence of large-scale commercial farms in the basin may be responsible for the increased agricultural marketing activities.

Marketing of farm produce in the study communities of the Upper Afram basin is well structured to safeguard the interest of food crop marketers. Most of them have constituted themselves into individual marketers and farmer-based associations such as the Yam Sellers Association; United Farmers Association; Kasapa Farmers Association; and the Vegetable Growers Association. The Upper Dayi Basin, on the other hand traditionally has been noted for rice production even though several other major food crops are cultivated in the area. Brown rice in particular is an important staple in this study area which is heavily patronized by the community members and traders. Thus, even though current environmental conditions may not be favourable for its cultivation brown rice persists as a marketing commodity to the extent that as far back as the 1980s, farmers started engaging in seasonal migration for rice cultivation in order to keep this traditional staple on the market (Gyasi & Ayivor, 1992).

Other major food crops sold on the markets in the study communities apart from maize, yam and rice include cowpea, groundnuts, okro, garden eggs, pepper, tomatoes, cassava, plantain, cashew, oil palm, watermelon, *agushi*, cocoa, banana, pineapple, cocoyam and ginger. Marketing of farm produce in the study basins as in other parts of the country is constrained by several factors such as poor marketing infrastructure, weak commodity value chains, absence of marketing skills and high transaction cost (MoFA, 2007; Ouma *et al*. 2010). The preference of agricultural markets for high yielding crops constitute a major constraint to the maintenance of agrobiodiversity (Lenzen *et al*., 2012; Rao *et al*., 2005; Gruère *et al*., 2006; Lamers, 2016). This has had adverse effect on crop diversity and subsequently deprived the markets of other indigenous food crop varieties that were previously cultivated by farmers.

Interactions with the farmers, traders, food crop sellers, individual marketers and members of farmer-based associations in the study communities corroborated this assertion.

This study showed that the eighty (80) NUCS identified in the Upper Afram basin and the thirty-two identified in the Upper Dayi basins are currently either not on the market or occur on a small scale. Responses elicited during the study have showed that the NUCS though useful in many ways do not appeal to buyers or attract a significant market share in the study areas due to factors similar to those suggested by FAO (2010). These factors include the low commercial value and competitive nature of NUCS compared to other crops; lack of incentive for farmers to maintain NUCS in their fields; and absence of market niches among others. Gruère *et al.* (2006) have also attributed factors such as lack of product knowledge, issues of demand and supply as well as inadequate economic information on NUCS often result in low market demand.

Responses of some market women on the availability of some marginalized food crop varieties as well as those that were previously available on the market but currently unavailable have also been highlighted. According to the women, some food crop varieties (especially tomatoes), had very high water and seed contents which made them practically unsuitable for storage. Some crops also had very low market demand and this led to their under cultivation. Some yam species (e.g. *kyirekumasi*), broke up easily during transportation leading to decay and subsequently financial losses and debts, so the marketers stopped patronizing them. Gruère *et al.* (2006) however argue that in order to ensure effective commercialization of NUCS there is the need to deal with the constraints hindering supply and marketing channels as well as the expansion and supply control mechanisms.

- Changing dietary habits and NUCS

Changes in dietary habits resulting from migration have been highlighted as one of the reasons for the decreased cultivation, marginalization and use of some local food crop varieties in the Upper Afram and Upper Dayi basins. This observation is important especially given the history of migration among ethnic groups in Ghana usually in search of new safe settlements for farming among others. This migration phenomenon is also confirmed in the 2008 Migration Country paper, where a similar historical migration trend that was influenced by the quest for new land settlements for agricultural purposes was observed (Awumbila *et al.*, 2008). Asante *et al.* (2015) also notes that migration has the potential to change diet and food habits. The assertion is further corroborated by Goel *et al*., 2004; Mohan, 2004) who also points out the direct relationship between migrations (whether rural or urban) and dietary changes.

The attribution to and the link between the changes in food consumption patterns and the unavailability of certain varieties of food crops and plant species in the study communities stem from the respondents' experience of the effects of migrations. According to them their children's inability to appreciate the importance of these indigenous food crop varieties was due to the unavailability of these food crops in their new settlements. This was attributed to the loss of some food crops arising from the movement from one location to the other. As a result, their children are deprived of the culinary skills that their parents and grandparents had especially in the preparation of some traditional meals resulting in dietary changes. This study revealed that most healthy traditional meals that were prepared from the presently marginalized food crop varieties are not readily available. For example, the presently marginalized food crops such as the leaves of some beans species such as *Akyɛ*, a brownish coloured beans; *Phaseolus spp*. (lima beans or locally called '*Apatram*'); pumpkin locally

referred to as *Efre; Kwahu nsusuaa* and *Monsorowa;* indigenous brown rice, referred to as '*Kamortintin*' among others all possess both nutritional and medicinal benefits. These food crops have become marginalized and therefore the younger generation have resorted to and developed taste for other "foreign foods". This rapid dietary transition has resulted in a change from healthy traditional plant-based diet to highly processed and convenience foods (Bosu, 2015; Galbete *et al.,* 2017). These unhealthy diets are unfortunately associated with diet related diseases such as obesity, cardiovascular diseases, type II diabetes and some cancers (Pedro & Benavides, 2006; Steyn *et al,* 2006; Mendez & Cristobal, 2008; WHO, 2017).

Again, due to the so called "civilization", human behaviour particularly dietary habits have changed to adjust to foods that take a shorter preparation time, often referred to as "fast foods" thereby moving away from the local foods such as bambara beans and pigeon pea which often take a longer period to prepare. Consumers especially the younger generation now want to spend less time in cooking hence the reason for the high patronage of packaged foods (take away or fast foods etc). With the advent of foreign ingredients and new technologies in our kitchen (microwave, refrigerators, etc), our traditional cuisines are constantly evolving. Changing gender roles is also contributing to changes in dietary habits. For example, career women are now shifting attention and finding ways to simpler and easier ways of food preparation. Some therefore resort to convenience foods. The traditional ritual of sitting and eating as a family is now seen as old fashioned and moving into 'individualistic eating'. In view of the above, there is the need to maintain traditonal dietary habits that will help promote these indigenous crops.

5.5 Households food security and NUCS

Until the early parts of the twentieth century the cultivation and availability of a wide range of indigenous food crop varieties and livestock breeds ensured that household food needs were adequately met (Stefanie & Amend, 2008). Reliance on these local food crop varieties therefore helped rural households and communities in Ghana particularly in the northern parts of the country to be able to adequately feed their families. Over the years however, a pattern of agricultural food production that emphasizes the cultivation of selected staple crops has replaced the traditional system that ensured the availability of some of these indigenous crop varieties (Bennet-Lartey and Oteng-Yeboah, 2008). This shift invariably has affected the diversity and availability of adequate food for rural households as the traditional farmers now have to focus on the cultivation of these staples in order to maintain their source of income. Studies on food security in Ghana have shown that food insecurity is now prevalent in the rural areas particularly in northern Ghana (WFP, 2012; Abubakari and Abubakari, 2015) even though the country is said to be generally food secure (MoFA, 2015). This is consistent with the assertion that food insecurity is largely a rural phenomenon (Ecker & Asselt, 2017).

This shortfall in food availability and adequacy among rural households is again confirmed by this study which showed that some rural households and communities within the middle belt of the country particularly in the Upper Afram and Upper Dayi basins experienced varying and considerable levels of adequate food supply during certain months of the year while other months experienced inadequate supply. These communities still experienced food insufficiency even though they comprised mainly of farming households who were actively engaged in crop farming. Biederlack and Rivers (2009) corroborates this observation in a related study in the Northern region where farming households which were known to produce food crops also experienced food shortages making them the most food insecure households.

In spite of the large-scale cultivation of food crops and the presence of commercialized farms in the two study basins, the findings of this study showed that most households experienced inadequate food supplies, a situation that could be attributed to the fact that most households offered most of their farm produce for sale leaving small quantities for home consumption. Another reason that could be attributed to the food insecurity situation is the lack of proper storage facilities for preserving the harvested crops. In the Upper Afram basin, maize and yam constituted the main commercial food crops while the Upper Dayi basin was associated mainly with commercial cultivation of cocoa. Most households are therefore engaged in the sale of these crops as source of livelihood. The food inadequacy issues among communities in the Upper Dayi basin could be attributed to the commercial cultivation of cocoa which has resulted in the conversion of most arable farm lands for cocoa production at the expense of the cultivation of other food crops.

Most households in the study basin have therefore employed various coping strategies such as skipping or reduction in the sizes of meals consumed by both adults and children. Farmers have also had to adopt alternate livelihoods (coping strategies) to obtain some income in order to buy food. The rearing of livestock (small ruminants) and fowls and the subsequent sale of these animals are some of the income generating strategies employed by the farmers. Receiving remittances from relatives is another way through which households are able to buy food to feed their families.

This study additionally found that several indigenous crop varieties that were previously cultivated in the study areas are now under cultivated and marginalized while others are no more cultivated. Meanwhile, engagements with the local farmers showed that these crops helped alleviate the hunger situation and provided nutritional security. Underutilisation, neglect and erosion of several food crop varieties in the study communities have implications

for food security among the rural households in the study areas. Several studies have confirmed the potential contribution of NUCS in addressing household food insecurity. The presently marginalized food crop varieties over the years played important roles in the lives of the households in the study areas. Most farmers and households who were also active consumers of these crops attested to the medicinal and cultural significance aside the nutritional benefits during the focus group discussions.

The NUCS according to some farmers possess certain inherent properties that enabled them to stay for longer periods without any signs of decay. Among these crops are some varieties of cocoyam, water yam and aerial yam. Water yam is also said to have a pleasant taste after storing for a certain period. This probably could be attributed to the reduction in the water content whilst in storage. Responses from the interviews also explain that some NUCS such as cocoyam and sweet potatoes are readily available for consumption serving as alternatives during periods when the staples like plantain and cassava are out of season. Others are also known for their high micronutrient content providing balanced diets for households. For example, *Agushi (Citrullus sp.), Apatram (Lima beans, Phaseolus sp.), Aleefu (Amaranthus) and Ayoyo (Corchorus sp.)* are good sources of Vitamin A, iron and protein which aid in preventive health care purposes (Omari *et al.*, 2017). These marginalized indigenous crop varieties have therefore over the years influenced food and nutritional security among the local people in the studied communities.

Nyadanu *et al.* (2015) in a study has highlighted the potential role of these NUCS in promoting nutrition and food security. Anzu (2016) also reiterated the important role of underutilised crop species in sustenance and the reduction of food insecurity. Mayes *et al.* (2012) has further argued that marginalised food crop varieties play key roles in addressing rural poverty through income generation and improving food security among rural

households. These corroborations are imperative as they point to the need to consider NUCS in the country's quest to address food insecurity at the local level.

5.6 General discussion

The choice of Upper Afram and Upper Dayi basins for the study is important as the two basins are known to possess relatively rich agrodiversity accounting for the wide variety of food crops and plant species in the areas. The two river basins differ slightly in their ecological conditions. These unique characteristics were also reflected in the study findings. A comparison of the findings of the study within the two basins showed that relatively high numbers of NUCS were recorded in the study communities in the Upper Afram basin. The Upper Afram basin also possessed a relatively rich agrodiversity compared to the Upper Dayi basin. Concerning the factors that affected general agricultural activities and particularly NUCS cultivation and use in the two basins, environmental changes such as soil exhaustion or changes in rainfall and temperature figures constituted the key concerns of the study communities of the Upper Dayi area. Agrochemical abuse by farmers result in the contamination of the water bodies within the basin, which finally flow into the Volta Lake. In the Upper Afram basin however, issues regarding markets dominated responses and constituted the key factor. Indiscriminate cutting down of the forest and its impact on the climate of the area was also identified as a source of concern for the people of Upper Dayi as the forest represent an important repository of food and other resources. All these uncontrolled human activities indirectly affect the river systems of the area. The final effect is manifested in the receding level of the Volta Lake as it is these smaller rivers that feed into it. This adverse impact of land use dynamics on the health of river systems is also corroborated

by Ayivor and Gordon (2012). River systems are also believed to be vital for the Earth system (Wu *et al.*, 2018).

5.6.1 The Resource-Based Theory (RBT) and the study findings

The over hundred NUCS identified during the study is a confirmation of the existence of a valuable plant resource that can be effectively exploited to help address household food insecurity among rural communities in Ghana. Many Sub Saharan African countries including Malawi, Nigeria, Cote d' Ivoire, Uganda, and Zimbabwe have also exploited this valuable plant resource to address food insecurity challenges (Padulosi *et al.*, 2013; FAO 2010).

The study objectives and propositions agree with the underlying principles of the Resource-based theory. The Resource-based theory is used in this study mainly to highlight the importance of NUCS as a valuable resource that can be exploited and maximized for the purposes of addressing food insufficiency concerns at the local level. The theory emphasizes the effective and efficient exploitation and utilization of all resources available to a state (Mahoney, 2011). Neglected and Underutilized Crops constitute an untapped and underutilized plant genetic resource that is available to the country especially as relates to their exploitation for addressing food insecurity challenges among rural folks.

The theory also notes that a resource must exhibit unique characteristics of being beneficial and also able to present opportunities. Findings of this study confirmed some of the beneficial and useful traits of NUCS and the opportunities they present to local people.

The theory further suggests that a firm or a nation will create economic value to the extent to which it is able to effectively exploit and utilize its valuable resource. This includes ensuring

that all possible constraints or factors that hinder the potential of the resource are dealt with and addressed. The study finding on the factors affecting NUC cultivation and use showed that the NUCS identified in the middle belt of the country are being constrained by agricultural practices as well as environmental and socio-economic factors. This finding is important as it suggests the need for deliberate actions aimed at dealing with the identified constraints. It is then that the country can effectively maximize the NUCS resource in line with the assertions of the Resource based theory.

5.6.2 The study propositions and findings

The propositions that informed this research relates mainly to how certain environmental and social factors could be responsible for the under cultivation or marginalization of some indigenous crop varieties also known as the neglected and underutilized crop species (NUCS) that are known in other jurisdictions in Sub Saharan Africa to contribute to the achievement of food security among rural households. Findings of this study therefore provide the basis for the confirmation of the propositions or otherwise. Reviewing the study propositions at this point will also help to align the relevant findings with the specific study proposition.

The propositions for the study included the following: **firstly** that most indigenous food crop varieties that could potentially help address food insecurity in rural households in Upper Afram and Upper Dayi basins are being marginalized, a situation that may lead to the over reliance on a few priority staple crops; **secondly,** prevailing agricultural practices are affecting the cultivation and promotion of these NUCS; and **thirdly** environmental and socio-economic factors are contributing to the decreased cultivation and production of the NUCS.

With respect to the first study proposition, the study findings confirmed various degrees of marginalization and under cultivation of some crop varieties among communities in the Upper Afram and Upper Dayi basins. Though major food crops currently cultivated in the two river basins were identified, several other food crop varieties that were previously grown but now under cultivated or marginalized were also inventorized. A total of one hundred and twelve marginalized food crops belonging to the following food crop categories: cereals, vegetables, legumes, root and tubers, tree crops, plantation and fruits were identified in both study areas. The proposition also sought to indicate that certain identifiable factors may be responsible for the trend and therefore any successful attempt to identify and address these constraints holds prospects for Ghana as these crop varieties are known to contribute to food security among rural households. The study also highlighted some of the various benefits and uses of the crops. The observed marginalization of these food crop varieties in the Upper Afram and Upper Dayi basins as shown from the study findings is important as it seeks to corroborate the first proposition for the study.

Regarding the second proposition, the findings revealed some of the adverse effects of current agricultural practices particularly agrochemical use on NUCS cultivation and use in the study areas. This proposition recognizes the effect of changing agricultural practices on crop and how current agronomic practices could be affecting crop production including NUCS. The study showed that farmers in the Upper Afram and Upper Dayi basins practiced traditional agro forestry and employed the traditional cropping systems: mixed cropping and fallow periods. These systems of farming allowed farmers to cultivate several indigenous food crop varieties. However, agrochemical use had significantly affected the traditional agronomic practices employed by the farmers in these study areas. Agrochemical abuse was prevalent among the farmers and this constituted one of the major agronomic constraints

affecting NUCS cultivation in the study areas. The uncontrolled use of these chemicals also limited the practice of intercropping which ensured cultivation of a wide range of the food crop varieties. Labour-intensive and time-consuming methods of cultivation, low productivity and limited water resources were identified as some of the key agronomic constraints influencing NUCS cultivation and use.

On the third proposition, the study corroborated the assertion that some environmental and socio-economic factors may be affecting NUCS cultivation and use in the two basins. This proposition sought to suggest that even though NUCS are known to thrive under harsh climatic conditions, factors such as rainfall and temperature changes as well as the land cover and land use changes could be responsible for decreased cultivation and use of NUCS. A trend analysis of the rainfall and temperature figures over a 40-year period pointed to changes in the rainfall and temperature patterns within both Upper Afram and Upper Dayi basins. Land use and land cover (LULC) analysis over an 18-year period also showed higher levels of LULC changes. These changes affected and continue to affect crop cultivation and production including varieties of indigenous food crops in the study areas.

5.6.3 The Sustainable Development Goals (SDGs) and the study findings

Situating the findings of this research in the context of the SDGs is important more particularly to the SDG 2 which broadly seeks to end hunger, achieve food security and improve nutrition and promote sustainable agriculture and more specifically access to diverse genetic resources including NUCS and the benefit sharing accruing from their use and their associated indigenous knowledge. The aim of the SDGs is to help address the social, economic and environmental dimensions of sustainable development for all member states. The SDGs also seek to build on the progress made and also address the “unfinished business”

of the Millennium Development Goals (MDGs). Member states including Ghana are therefore expected to domesticate these goals and take deliberate actions that will contribute to the attainment of the goals and targets especially given their potential to address global development challenges.

The operationalisation and achievement of the Sustainable Development Goals (SDGs) therefore is a major concern for many developing countries including Ghana. This is particularly due to the relatively weak performance recorded in the attainment of most of the Millennium Development Goals (MDG) targets even though some considerable progress was made on individual targets in different countries. The SDGs consist of seventeen goals and one hundred and sixty-nine targets but of particular importance to this discussion is the SDG 2.1 and 2.5. Findings of this study however relate particularly to the social and environment dimensions, the SDG 2.1 which seek to ensure access to food by all people by (including rural households) 2030 as well as SDG 2.5 which emphasizes the need for the maintenance of genetic diversity and the utilization of genetic resources for food security by 2020. It can be inferred from the SDG 2.5 therefore that the loss of genetic diversity or decline in agrobiodiversity is partly responsible for the current state of global food insecurity. Food insecurity among member states therefore remains a major challenge that requires deliberate action aimed at reducing or eliminating the phenomenon. The conversation around the need to maintain genetic diversity is critical as most countries including Ghana have witnessed widespread decline.

This discussion is important as agricultural biodiversity constitute an essential component in the sustainable delivery of a more secure food supply. The Ghana Millennium Development Goal (MDG) 2015 report in assessing some of the challenges that militated against the achievement of MDG 1 which sought to eradicate extreme poverty and hunger also

highlighted low productivity, especially in agriculture among others, as hindering growth in agriculture (NDPC, 2015). Meanwhile agriculture plays a major role in food security in Ghana. Inadequate local food production has often led to the continued importation of some food crops and commodities to address shortfalls in domestic supply. Achieving the targets set out under the SDG 2 is imperative as it also fits into the Ghana's agriculture sector policy strategy of meeting the food insecurity concerns among its citizens. The need for innovation has also been emphasized as a means of enhancing food security. It is for this reason that local research efforts such as the present research findings on the status and potential of genetic resources including NUCS in addressing household food insecurity in the agro-diverse areas of Ghana particularly in the Upper Afram and Upper Dayi basins are recognized and utilized. Such actions support and demonstrate Ghana's commitment to the SDG 2 and the global fight to address global food insecurity. The findings of this study also reinforce the suggestion by Chivenge *et al*. (2015) on the need to explore the potential of Sub Saharan Africa's (SSA) agro-biodiversity in order to widen the food basket as part of efforts to attain the SDGs particularly related to food security.

5.6.4 Agriculture and food policy framework and the study findings

The findings of this research create the need for some attention for policy action regarding NUCS cultivation and promotion in Ghana. Whilst agriculture policies exist in many developing countries issues regarding NUCS have not been fully or sufficiently emphasized in many of these policies. In countries such as Jordan, Nepal, Papua New Guinea, Peru, Uzbekistan, Vietnam and Zambia among others, agricultural sector policies have not specifically focused on underutilized crops (Chishakwe, 2008). Agriculture polices in countries such as Nepal and Jordan emphasize on the development of commercial crops on a large scale with little or no specific reference to NUCS. It has been argued however that even

though special emphasis has not been placed on NUCS in agricultural policies, the generalized way in which these policies have been framed makes them applicable to NUCS.

In Ghana however there is currently no single detailed policy provision on NUCS despite their known potential impact in contributing to food security. The findings of this study therefore provide some useful indication and basis for the call to integrate NUCS concerns in the Food and Agriculture Sector Development Policy (FASDEP II). The Medium-Term Agricultural Development Programme (MTADP) which was introduced between 1991 and 2000 focused primarily on promoting institutional reforms needed for increased investments and market-oriented agricultural growth.

This was followed by the Accelerated Agricultural Growth and Development Strategy (AAGDS) which aimed among others to promote high-value crops and diversify agricultural exports in 2000. The Ghana Poverty Reduction Strategy (GPRS I) introduced between 2003 and 2005 also contained a strategy that focused on the creation of incentives for the participation of the private sector in agricultural investments as well as the introduction of modern production technologies. The second medium term plan, the Growth and Poverty Reduction Strategy (GPRS II) also focused on the potential non-traditional export crops such as pineapples, mangoes, cashew nuts and vegetables as part of the effort to reduce reliance on traditional export commodities, particularly cocoa. The current long-term policy framework for the agriculture sector, FASDEP II also promotes selected priority or major crops based on their economic importance; their capacity to contribute to export diversification and food security to the neglect of underutilized crops. Increased crop production and food security concerns therefore constitute an important component of FASDEP; however, the policy strategies emphasize the cultivation of selected major crops.

Widening the national food basket to address food insecurity particularly among indigenous communities will require a deliberate policy action that also integrates the NUCS. Research findings such as Nyadanu & Lowor, (2014) and Nyadanu *et al*., 2015 among others have also provided useful information on NUCS in Ghana. These study findings further reinforce and provide evidence of several indigenous varieties of marginalised food crops that were cultivated and used in the past but presently underutilized. Such policy action will also create the needed awareness that will stimulate more interest in research into other unexplored aspects of NUCS in Ghana. It is therefore important that the policy strategies outlined in FASDEP II is expanded to capture NUCS concerns especially given their known contribution to the attainment of food security among rural households.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This chapter presents the summay, conclusions and recommendations emanating from the study. An overview of the study propositions and findings has also been revisited. The conceptual framework used for the study helped to analyze and explain the linkages between the various concepts. The Resource Based Theory (RBT) also served as a lens in highlighting and understanding how NUCS as a valuable resource can be used to help address household food insecurity.

The underlying propositions that have informed the study are as follows: that most indigenous food crop varieties that could potentially help address food insecurity in rural households in central Ghana are being marginalized; that prevailing agricultural practices may be affecting the cultivation and use of NUCS in the Upper Afram and Upper Dayi basins; and that environmental and socio-economic factors are contributing to the decreased cultivation and use of NUCS in the middle belt of Ghana.

6.1 Summary of the findings

Findings of the study revealed that several varieties of indigenous food crops in Central Ghana are currently under cultivated, marginalized and neglected due to some identifiable causes. Among the key constraints identified include labour-intensive and time-consuming methods of cultivation, low productivity and limited water resources.

The study produced an inventory of one hundred and twelve NUCS found within the food crop categories including cereals, legumes, vegetables, root and tubers, and trees and

plantations in both Upper Afram and Upper Dayi basins. Several indigenous varieties of some of Ghana's key staple crops such as yam and rice were no more cultivated and on the verge of extinction. Concerning the benefits and uses of NUCS, the study findings showed that apart from their use as food, medicine, dyes, soap making, fuel wood and livestock feed, some NUCS found in central Ghana play very important roles in the cultural practices and traditional ceremonies.

In terms of farming and agronomic practices and their influence on NUCS cultivation, the study showed that, study areas in the past, practiced traditional agro forestry and employed the traditional cropping systems: mixed cropping and fallow periods. The study also found that the traditional cropping system particularly mixed cropping allowed farmers to cultivate many indigenous food crop varieties that presently are no more cultivated.

The study further observed that traditional agronomic practices have been heavily affected with the introduction of agrochemical use. Agrochemical abuse was found to be widespread among the farmers and this constituted one of the major agronomic constraints influencing the cultivation of NUCS in the study areas. It was also found that, effects of uncontrolled agrochemical use were limiting the practice of intercropping which ensured cultivation of a wide range of indigenous crop varieties.

Regarding environmental and social factors affecting NUCS cultivation, the findings revealed a changing rainfall pattern and increases in average temperatures in both river basins. The observed climate variability was found to affect agricultural activities including crop production and crop diversity leading to decline and gradual loss of varieties of indigenous food crops in the study areas.

The study also reported remarkable changes in land use and land cover (LULC) in the two study basins for the 18-year period spanning from 2000 to 2018. Higher levels of LULC changes were recorded in the Upper Afram basin as compared to the Upper Dayi basin. Population increases in both basins over the period contributed to the observed land use and land cover changes. The study also showed that some of the indigenous food crop varieties were marginalized largely due to the current focus on cultivation of a few staple crops.

On the influence of market dynamics on NUCS in the study areas, the findings report that the staple crops as well as the presently marginalized crops in the study communities were both affected by the general market dynamics, however, the marginalized crops usually did not command a significant market share compared to the priority crops which enjoyed high patronage due to the market and consumer preference arising from the prioritisation of the staple crops.

On the state of household food security, the study revealed that households in the study communities experienced varying and considerable levels of adequate food supply during certain months of the year while in other months there was insufficient food supply. The study however established that quite a significant number of households were food insecure even though on the national level the country can be said to be food secure.

The findings established, based on indigenous knowledge from the farmers that the currently marginalised and neglected indigenous food crop varieties have historically influenced and played a critical role in meeting household food needs and contributing to food security among the local people in the study communities. Finally, the study revealed the current policy gap with regards to NUCS cultivation and use in addressing food insecurity among rural households in Ghana.

The findings of this study reinforce the need to reconsider the ways in which food insecurity issues among rural households are addressed in Ghana. This is important due to the persistent cycle of inadequate supply and unavailability of food experienced among rural and deprived communities in certain parts of the country particularly the Northern sector of the country. Neglected and underutilized crops hold the key to addressing the food inadequacy challenges among the rural communities in the country.

6.2 Conclusion

Marginalization of indigenous food crop varieties and plant species due to the current emphasis on the major staples or priority crops in Ghana continues to be a major challenge. Nevertheless, promotion and use of NUCS have been known to contribute to food security among indigenous communities. Several varieties of indigenous food crops that were previously cultivated are currently marginalised and underutilised with some species on the verge of complete erosion. The diverse nature of NUCS in the Upper Afram and Upper Dayi basins provides useful information and basis for the need to further explore the potential of other agroecologically diverse areas of the country with the view to generating a national comprehensive inventory of these important but apparently overlooked food crop varieties. These findings confirm the proposition that most indigenous food crop varieties are currently being marginalized and under cultivated in the areas studied. These findings demonstrate the untapped potential of NUCS particularly in the middle belt of the country.

The effects of the introduction and increased agrochemical use have largely influenced farmers to lean more towards the practice of monocropping unlike the traditional mixed cropping or intercropping that encouraged the cultivation of a wide variety of local food crops. This also agrees with the underlying assumptions of the study.

Climate variability and changes in land use and land cover generally affected agricultural activities in the study areas and this has somewhat also influenced crop diversity and the current under cultivation of these local food crop varieties. Even though marketing of agricultural produce generally is constrained by some factors in the study areas, the commercialization of NUCS has relatively been adversely affected particularly due to their relatively low market value and also consumer preference for the staples. It is therefore imperative that these market constraints that hinder the effective commercialization of the NUCS in the two basins are given the necessary attention. Changes in dietary habits also influenced the cultivation and use of the NUCS. Analysis of the environmental factors confirmed the role of climate variability and land-use and land cover changes in the current marginalization. These results also corroborate the propositions of the study.

The findings of the study revealed a pattern that suggests food sufficiency during certain months and insufficiency in other months of the year. Most households however were found to be food insecure and this implied that food insecurity among rural households and indigenous communities still seem to be prevailing even though on the national level the country is food secure. Considering Ghana's growing population and level of food insecurity in rural households as seen in related studies, there is the need to expand the range of food crops to cover NUCS given their known contribution to addressing food and nutritional insecurity among rural households.

This study concluded that the currently marginalised local food crop varieties have over the years influenced and played a critical role in addressing household food needs and contributed to food security among the local people in the study communities. This is important as Ghana's efforts at attaining food security also feeds into the attainment of the SDGs particularly those related to the achievement of food security. These findings

demonstrate the need and basis for a reconsideration of the current lack of sufficient attention to the policy issues related to NUCS in Ghana's long-term agriculture sector policy.

6.3 Recommendations

The study identified several varieties of food crops that have either been marginalized or underutilized and the inhibiting factors responsible for their underutilization. These findings bring to the fore the need to pursue certain actions in order for Ghana to benefit from these marginalized crops. The Resource-based theory notes that a firm or a nation can create economic value if it is able to effectively exploit and utilize its valuable resources. Ghana can therefore exploit and maximize this known valuable plant resource, NUCS to address its persistent food insecurity challenges in the rural areas especially given their known contribution to food security in other Sub Saharan African countries.

It is therefore suggested in the light of the above that a nation-wide survey is undertaken as this study and other previous surveys have not fully covered the whole country. This will produce a national NUCS inventory or NUCS country baseline data. Such comprehensive database will among other things stimulate more intense and focussed ethnobotanical and other related studies. The establishment of new gene banks in other parts of the country is suggested. Decentralization of the gene banks from the centralized one at PGRRI at Bunsu in the Eastern region can enhance effective conservation and reduction in the loss of crop varieties. Additionally, local expert farmers will have to be identified and engaged to also serve as the trustees of these crops.

The several NUCS identified during the study were found to have many uses and benefits and therefore it would be important this knowledge is made readily available and accessible. In addressing the challenge of the availability of relevant and sufficient knowledge of the use

and benefits of theses crops among consumers and the public at large, it is recommended that a more focussed and vigorous media campaign as well as the organization of regular NUCS focused food fairs to promote the local dishes prepared from these food crops at the local (village), district and regional levels including Ministry of Tourism. This will help to expose and raise public interest (both rural and urban) on the benefits and uses of NUCS (including the medicinal and nutritional value of these crops).

The effects of agricultural practices such as agrochemical abuse and the widespread adoption of the monocropping system of farming were observed during the study. It is therefore recommended that the local farmers at the district and community level are intensely sensitized on the controlled and efficient use of agrochemicals. The farmers must be encouraged not to completely neglect some of the good traditional systems of farming particularly because the wild relatives of the NUCS thrive in natural and undisturbed environments. Adequate technical support services and incentives that will encourage the local farmers to refocus and maintain the cultivation of wide varieties of indigenous food crops in their farms will also have to be pursued.

Bush burning and uncontrolled felling of the forest trees constituted a major environmental challenge for the people in Upper Dayi particularly because the forest constituted an important repository of a variety of food crops and other resources for them. Instituting and enforcing sanctions to ensure controlled human activities in the forest is recommended.

Widening the national food basket to integrate NUCS with the view to helping address the persistent food insecurity challenges in the rural areas of the country will require deliberate policy action. It is therefore recommended that the agriculture policy strategy that relates to food security and emergency preparedness in the national Agricultural sector policy

(FASDEP II) be reviewed to include comprehensive and practical guidelines on how NUCS can be promoted and maximized in order to achieve this goal.

Increased NUCS focussed research, particularly in the relevant public research institutions such as the Crops Research Institute and the Plant Genetic Resources and Research Institute of the Council for Scientific and Industrial Research as well as the private and public sectors with the view to augment the current local research efforts will be critical. This effectively will require increased government interest and willingness to facilitate and attract funding opportunities.

REFERENCES

Aboagye, L. M., Obirih-Opareh, N., Amissah, L., & Adu-Dapaah, H. (2007). *Analysis of existing national policies and legislation that enable or inhibit the wider use of underutilized plant species for food and agriculture in Ghana. Report.* Ghana: Council for Scientific and Industrial Research, Italy, 31p.

Aboagye, L.M., Amoatey, H.M., Asante, I. K., Obiri-Opareh, N. & Ofosu, I.W (2010). Ghana Country Report on Neglected and Underutilized Species. Report, Accra, 39p.

Aboagye, L. M., Nyadanu, D., Opoku-Agyeman, M. O., Owusu, S. K.1 & Asiedu-Darko, E. (2015). Survey of diversity and production of yams in four communities in Southern Ghana. *African Journal of Agricultural Research,* 10 (24): 2453-2459.

Abubakari, F. & Abubakari, F. (2015). Effects of climate changing on food crop production system in Ghana. Acad. Res. J. Agri. Sci. Res. 3(4): 76-79.

Adejuyitan, J. A. (2011). Tigernut processing: Its food uses and health benefits. *American Journal of Food Technology*, 6(3): 197-201.

Almarria, K & Gardinera, P. (2014). Application of resource-based view to project management research: supporters and opponents. Procedia - *Social and Behavioral Sciences*, 119: 437 – 445.

Ampofo, S., Ampadu, B., Samuel K. & Abanyie, S. K. (2015). Landcover Change Patterns in theVolta Gorge Area, Ghana: Interpretations from Satellite Imagery. *Journal of Natural Sciences*, 5 (4): 71- 82.

Anzu, S. (2016). Underutilised plant species need attention. Available at http://www.thenational.com.pg/underutilised-plant-species-need-attention

Arora, R. K. (2014). *Diversity in underutilized plant species: An Asia-Pacific perspective*. Biodiversity International, 203p.

Asante, K. A & Ntow, W. J. (2009). Status of Environmental Contamination in Ghana, the perspective of a research Scientist. *Interdisciplinary Studies on Environmental Chemistry — Environmental Research in Asia*, pp. 253–260.

Asante, M. D., Asante, B. O., Acheampong, G. K., Offei, S. K., Gracen, V., Adu-Dapaah., H & Danquah, E. Y. (2013). Farmer and consumer preferences for rice in the Ashanti region of Ghana: Implications for rice breeding in West Africa. *Journal of Plant Breeding and Crop Science*, 5 (12): 229-238.

Asante, M., Pufulete, M., Thomas J., Wiredu E., & Intiful F., (2015). Food consumption pattern of Ghanaians living in Accra and London. *International Journal of Current Research,* 7 (5): 16216-16223.

Assogba P., Ewedje E.E. B. K., Dansi A., Loko Y. L. Adjatin A, Dansi M. & Sann A. (2015). Indigenous knowledge and agro-morphological evaluation of the minor crop Kersting's groundnut (Macrotyloma geocarpum (Harms) Marechal et Baudet) cultivars of Benin. *Genet Resour Crop Evol.* DOI: 10.1007/s10722-015-0268-9.

Awumbila, M., Manuh, T., Quartey, P., Tagoe, C. A. & Bosiakoh, T. A., (2008). *Migration Country Paper – Ghana,* Oxford: International Migration Institute.

Ayivor, J. S., Pabi O., Ofori B. D., Yirenya-Taiwiah D. R. & Gordon C. (2016.) Agro Diversity in the Forest-Savannah Transition Zone of Ghana: A Strategy for Food Security against Climatic and Socio-Economic Stressors. *Environment and Natural Resources Research.* 6 (1): 1-12. doi:10.5539/enrr.v6n1p1

Ayivor, J. S. & Gordon, C. (2012). Impact of Land Use on River Systems in Ghana *West African Journal of Applied Ecology,* 20 (3): 83-95.

Ayivor, J. S. & Ntiamoa-Baidu, Y. (2015). Assessing the socio-economic stressors of Ghana's only Strict Nature Reserve – Kogyae. *Parks,* 21(2): 88-101.

Azam-Ali, S. N. (2010). Fitting underutilised crops within research-poor environments: Lessons and approaches. *South African Journal of Plant and Soil*, 27(4), 293-298.

Baishya, K. (2015). Impact of agrochemicals application on Soil quality degradation—a review. *International Journal of Science, Technology and Management*, 4(01): 220-228.

Bala Ravi S, I Hoeschle-Zeledon, MS Swaminathan & E Frison (eds) (2006). Hunger and Poverty: The Role of Biodiversity, MS Swaminathan Research Foundation and IPGRI, India and Rome, 232p.

Bala Ravi, S., Hrideek, T.K., Kishore Kumar, A. T, Prabhakaran, TR., Mal, B., & Padulosi, S (2010). Mobilizing Neglected and Underutilized Crops to Strengthen Food Security and Alleviate Poverty in India. *Indian J. Plant Genet. Resour.* 23(1): 110-116.

Bals, C., Harmelling, S. & Windfuhr, M. (2008). Climate change, food security and the right to adequate food. Diakonie Katastrophenhilfe, Brot fuer die Welt and Germanwatch. Stuttgart, Germany.

Barney, J. B. (1991). Firm resources and sustained competitive advantage. *Journal of Management,* 17: 99-120.

Barney, J. B. (2002). *Gaining and Sustaining Competitive Advantage*: Prentice Hall, 520p.

Barney, J. B., Ketchen, D. J., & Wright, M. (2011). The Future of Resource-Based Theory: Revitalization or Decline? *Journal of Management,* 37 (5):1299-1315.

Bennett-Lartey, S. O, and Oteng-Yeboah, A. A. (2008). Ghana Country Report on the state of plant genetic resources for food and agriculture, 32p.

Bhattacharjee, R**.** (2009). Harnessing Biotechnology for Conservation and Increased utilization of Orphan Crops. *African Technology Development Forum Journal.* 6: (3). 24-31.

Biederlack, L., & Rivers, J. (2009). Comprehensive food security and vulnerability analysis (CFSVA): Ghana. United Nations World Food Programme.

Bicík, I., Kupokova, L. Jelecek, L., Kabrda, J., Stych, P., Janousek, Z., and Winklerova, J. (2015). *Land Use Changes in the Czech Republic 1845–2010,* Springer Geography, Springer International Publishing Switzerland.

Bioversity International (2017). *Mainstreaming Agrobiodiversity in Sustainable Food Systems: Scientific Foundations for an Agrobiodiversity Index.* Biodiversity International, Rome, Italy, 30p.

Bosu, W. K. (2015). An overview of the nutrition transition in West Africa: implications for non-communicable diseases. Proceedings of the Nutrition Society. 74(4):466-477.

Bryson, J. M., Ackermann, F. & Eden, C. (2007). Putting the Resource based view of strategy and distinctive competencies to work in public organizations. *Journal of Management* Public Administration Review.

Callo-Concha, D., Gaiser, T. & Ewert, F. (2012). Farming and cropping systems in the West African Sudanian Savanna. WASCAL research area: Northern Ghana, Southwest Burkina Faso and Northern Benin. *ZEF Working Paper 100*. Bonn, Germany.

Chandrasekaran, B., Annadurai, K., & Somasundaram, E. (2010). *A textbook of agronomy.* New Delhi: New Age International (P) Ltd., Publishers.

Chappell, M. J. & LaValle, L.A. (2011). Food security and biodiversity: Can we have both? An agroecological analysis. *Agric. Human Values, 28,* 3–26. DOI

10.1007/s10460-009-9251-4

Chishakwe, N. E. (2008). The role of policy in the conservation and extended use of underutilized plant species: a cross-national policy analysis. Global Facilitation Unit for Underutilized Species, Rome, Italy, and the Genetic Resources Policy Initiative, Nairobi, Kenya.

Chivenge, P., Mabhaudhi, T., Modi, A. T., & Mafongoya, P. (2015). The potential role of neglected and underutilised crop species as future crops under water scarce conditions in Sub-Saharan Africa. *International Journal of Environmental Research and Public Health*, 12(6), 5685-5711.

Cocks, M. & Dold, T. (2004). The informal trade of Cassipourea flanaganii as a cosmetic in South Africa, in: Sunderland, T., Ndoye, O. (Eds.), Forest products, livelihoods and conservation. Case studies of non-timber forest product systems. Africa. CIFOR, Bogor, 2:73-90.

Cohen, H., Manion, L. & Morrison, K. (2007). *Research methods in education*. London: Routledge theory of the firm? *Journal of Management,* 17 (1): 121 – 154.

Conner, K.R., (1991), 'A historical comparison of resource-based theory and five schools of thought within the industrial organization economics: Do we have a new theory of the firm?', *Journal of Management,* 17, 121-154.

Cothran R. D., Brown J. M., & Relyea R. A. (2013). Proximity to agriculture is correlated with pesticide tolerance: evidence for the evolution of amphibian resistance to modern pesticides. Evolutionary Applications, 6(5):832-841. doi: 10.1111/eva.12069

Creswell, J. (2003). *Research design: Qualitative, quantitative and mixed methods approaches (2nd ed.).* Thousand Oaks, CA: SAGE Publication

Creswell, J. (2009). *Research design qualitative, quantitative and mixed methodsapproaches*. Los angeles: Sage Publications.

Cunningham, A. B. (2001). *Applied ethnobotany: People, wild plant use and conservation. people and plant conservation manual.* London: Earth scans Publication Ltd.

Dansi, A., Vodouhè, R., Azokpota, P., Yedomonhan, H., Assogba, P., Adjatin, A., Loko, Y. L., Dossou-Aminon, I., & Akpagana, K. (2012). Diversity of the neglected and underutilized crop species of importance in Benin. *The Scientific World*

Journal, 1-19. doi:10.1100/2012/932947.

Dasgupta, A., & Baschieri, A. (2012). Vulnerability to climate change in rural Ghana: Mainstreaming climate change in poverty-reduction strategies. *Journal of International Development,* 22, 803-820.

Ebert, A. W. (2014). Potential of underutilized traditional vegetables and legume crops to contribute to food and nutritional security, income and more sustainable production systems. *Sustainability*, 6(1), 319-335.

Ecker, O. & Asselt, J. V. (2017). Food and Nutrition Security in Transforming Ghana. A Descriptive Analysis of National Trends and Regional Patterns. IFPRI Discussion Paper 01650 Development Strategy and Governance Division, International Food Policy Research Institute.

Eniola, A. A. & Entebang, H. (2015). Small and medium business management-financial sources and difficulties. *International Letters of Social and Humanistic Sciences,* 58, 49-57. https://doi.org/10.18052/www.scipress.com/ ILSHS.58.49

Environmental Protection Agency, Ghana (EPA). (2011). Ghana's Second National Communication to the United Nations Framework Convention on Climate Change. Accra, Ghana, 168p.

Erle, E., & Pontius, R. (2007). "Landuse and landcover change." In: Encyclopedia of Earth". Eds. Cutler J. Cleveland. Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment. Retrieved from https://web.archive.org/web/20070503192914/http://www.eoearth.org/article/Landuse_and_landcover_change

FAO (1996). Global plan of action for the conservation and sustainable utilization of plant genetic resources for food and agriculture. Section 12. Rome, Italy: FAO.

FAO (1998). The state of food and agriculture. Food and Agriculture Organization of the United Nations, FAO, Rome.

FAO (2008). *Climate change and food security: A framework document.* Rome, Italy: FAO.

FAO (2010). Second report on the state of the world's plant genetic resources for food and agriculture. Rome, Italy: Commission on Genetic Resources and Agriculture, FAO.

FAO (2013). The State of Food Insecurity in the World 2013: The Multiple Dimensions of Food Security. Food and Agricultural Organization, Rome, Italy, ISBN-13: 9789251079164, pp:8-15.

FAO (2014). *Save food: Global initiatives on food loses and waste reductions: Key findings*. Rome: The Food and Agriculture Organization of the United Nations.

FAO (2016). *Guidance Note: Gender, food security and nutrition in protracted crises: Women and girls as agents of resilience*. Rome: FAO.

FAO (2017). *The state of food insecurity in the world.* Rome: Food and Agriculture Organization (FAO).

Fanzo, J., Hunter, D., Borelli, T & Mattei, T. (2013). *Diversifying food and diets: using agricultural biodiversity to improve nutrition and health*, Issues in agricultural biodiversity – First edition. Earthscan. Routledge New York, 368p.

Galbete, C., Nicolaou M., Meeks K. A., de-Graft A. A., Addo J, Stephen K. Amoah S. K., Smeeth L., Owusu-Dabo E., Klipstein-Grobusch K., Bahendeka S., Agyemang C., Mockenhaupt F. P., Beune E. J., Stronks K., Schulze M. B. & Danquah I. (2017). Food consumption, nutrient intake, and dietary patterns in Ghanaian migrants in Europe and their compatriots in Ghana. *Food & Nutrition Research*, Vol. 61 10.1080/16546628.2017.1341809.

Gaoue O. G & Ticktin T. (2008). Impacts of bark and foliage harvest on *Khaya senegalensis* (Meliaceae) reproductive performance in Benin, *Journal of Applied Ecology*, 45(1):34 – 40.

Genius, M., Pantzios, C. J., & Tzouvelekas, V. (2006). Information acquisition and adoption of organic farming practices. *Journal of Agricultura1 and Resource Economics 3*1 (1), 93-113.

Ghana Statistical Service (2014b). *2010 Population and Housing Census, District Analytical Report, Hohoe Municipality*. Ghana Statistical Service.

Ghana Statistical Service (2014a). *2010 Population and Housing Census, District Analytical Report, Ejura Sekyedumase Municipal*. Accra: Ghana Statistical Service.

Ghana Statistical Service (2014). *Poverty trends in Ghana: Ghana Living Standard Survey Round Six Reports,* Accra: Ghana Statistical Service.

Ghana Statistical Service (2016). *Food import bills*. Accra: Trade Statistics Department. Accra: Ghana Statistical Service.

Ghana Statistical Service (2017). *Population and housing census*. Accra: GSS.

Gyasi, E.A. & Ayivor, J.S. (1992). Rural-rural migration: the cases of Likpe seasonal migrant rice farmers. *Malaysian Journal of Tropical Geography*. 23 (1):13-22.

Gyasi, E. A. & J. I. Uitto, Eds. (1997). *Environment, Biodiversity, and Agricultural Change in West Africa: Perspectives from Ghana,* Tokyo: United Nations University Press.

Gill, N. S., Bansal, R. K., Manju, G., Shailja, S., Arunachalam, M., & Manoj, B. (2010). Evaluation of antioxidant, anti-inflammatory and analgesic potential of Citrullus lanatus seed extract in rodent model. *Internet Journal of Nutrition and Wellness*, 9(2). 1-7

Goel, M. S., McCarthy E. P., Phillips, R. S., & Wee, C. C. (2004). Obesity among US immigrant subgroups by duration of residence. *Journal of American Medical Association,* 292:2860–2867.

Grewal, A. S., Singla, A., Kamboj, P., & Dua, J. S. (2017). Pesticide Residues in Food Grains, Vegetables and Fruits: A Hazard to Human Health. *J. Med Chem Toxicol* 2(1): 1-7.

Gruère, G., Giuliani, A. & Smale, M. (2006). 'Marketing underutilized plant species for the benefits of the poor: a conceptual framework', IFPRI EPT Discussion Paper, Washington, DC, 36p.

Habbershon, T. G. & Williams, M. L (1999). A Resource-Based Framework for assessing the strategic aadvantages of family firms, *Journal of Management* 12 (1): 1-25.

Haddad, W. & Demsky, T. (1995). *Education Policy-Planning Process: An Applied Framework.* Paris: UNESCO: International Institute for Educational Planning. 94p.

Hawtin, G. (2007) Underutilized plant species research and development activities—review of issues and options. GFU/ICUC. International Plant Genetic Resources Institute, Rome, Italy. 78p.

Hillman, A. J., Michael, C. Withers, M. C & Collins, B. J. (2009). Resource Dependence Theory: A Review. *Journal of Management,* 35(6) 1404– 1427.

International Panel on Climate Change (IPCC) (2007). The fourth assessment report of the Intergovernmental Panel on climate change. Geneva: IPCC;112p.

International Panel on Climate Change (IPCC) (2014). Fifth Assessment Report (AR5): http://www.ipcc.ch/report/ar5/.

International Plant Genetic Resources Institute (IPGRI) (2002). *Neglected and underutilized*

plant species: Strategic action plan of the International Plant Genetic Resources Institute. Rome: IPGRI.

Jacobsen, S. E., Sørensen, M., Pedersen, S. M. and Weiner, J. (2013). Feeding the world: Genetically modified crops versus agricultural biodiversity. *Agronomy for Sustainable Development*, 33 (4), 651–662.

Jaenicke, H. & I. Hoeschle-Zeledon, Eds. (2006). Strategic framework for underutilized plant species research and development, with special reference to Asia and the Pacific, and to Sub-Saharan Africa: International Center for Underutilized Crops, Colombo, Sri Lanka and Global Facilitation Unit for Underutilized Species, Rome, Italy.

Jarvis, D. I., Padoch, C. & Cooper, H. D. (2007). Managing biodiversity in agricultural ecosystems. Columbia University Press, New York, USA, pp105.

Jose, M. & Padmanabhanb, M. (2015). Dynamics of agricultural land use change in Kerala: a policy and social ecological perspective. *International Journal of Agricultural Sustainability* http://dx.doi.org/10.1080/14735903.2015.1107338.

Josephson A. L., Ricker-Gilbert, J., & Florax J.G.M. (2014). How does population density influence agricultural intensification and productivity? Evidence from Ethiopia. *Food Policy*. 48: 142-152.

Kenyon, L & Fowler, M, (2000). Factors affecting the uptake and adoption of output of crop protection research on yams in Ghana. Unpublished Paper, Natural Resource International Limited, UK.

Kotler, P. & Keller, K. L. (2012) 14th ed. Marketing management. Pearson Education, Inc. publishing as Prentice Hall, One Lake Street, Upper Saddle River, New Jersey.

Laker, M. (2007). Introduction to the special edition of Water SA on indigenous crops, water and human nutrition. Water SA 33 (3) http://www.wrc.org.za.

Lambin, E. F., Baulies, X., Bockstael, N., Fischer, G., Krug, T., Leemans, R., & Moran, E. F., Rindfuss, R. R., Sato, Y, Skole, D, Turner II, B. L., Vogel, C. (1999). Land-Use and Land-Cover Change Implementation Strategy. Bonn: The International Human Dimensions Programme (IHDP). IGBP Report No. 48 and IHDP Report No. 10.

Lambin E. F. & Geist H. (Eds.) (2006). Land-Use and Land-Cover Change. Local Processes and Global Impacts Springer, Berlin, pp1–8. Germany.

Lamers, H. A. H., Kruijssen, F., Sthapit, B & Rao, V. R. (2016). How can markets contribute to the conservation of agricultural biodiversity on farms? From theory to practice. *Markets and conservation of biodiversity*, 236-384.

Lemba, J.K. (2009). Intervention model for sustainable household food security in the dry lands of Kenya: Case study of Makueni district. PHD Thesis University of FBW, Ghent University.

Lenzen, M., Moran, D., Kanemoto, K., Foran, B., Lobefaro, L., & Geschke, A. (2012) 'International trade drives biodiversity threats in developing nations', *Nature*, 486 (7401):109–112.

López-Noriega, I., Dawson I.K., Vernooy, R., Köhler-Rollefson, I., & Halewood, M. (2017). Agricultural diversification as an adaptation strategy. *Agriculture for Development*, 30:25-28.

Mabe, F. N., Talabi, K. and Danso-Abbeam, G. (2017). Awareness of health implications of agrochemical use: Effects on Maize Production in Ejura-Sekyedumase Municipality, Ghana.

Magbagbeola, J. A.O., Adetoso, J. A, & Owolabi, O. A (2010) Neglected and underutilized species (NUS): a panacea for community focused development to poverty alleviation/poverty reduction in Nigeria. *Journal of Economics and International Finance*, 2(10):208–211.

Mabhaudhi, T., Modi, A.T., & Beletse, Y.G. (2011). Growth response of selected taro [Colocasia esculenta (L.) schott] landraces to water stress. In ISHS Acta Horticulturae 979: II International Symposium on Underutilized Plant. Species: Crops for the Future-Beyond Food Security; ISHS (International Society for Horticultural Science): Leuven, Belgium.

Mabhaudhi, T., O'Reilly, P., & Walker, S. (2016). The role of underutilised crops in Southern African farming systems: A scoping study; Gaborone, Botswana, 16p.

Mabhaudhi, T., Chimonyo V.G.P., Chibarabada, T. P. & Modi, A. T. (2017). Developing a Roadmap for Improving Neglected and Underutilized Crops: A Case Study of South Africa. *Front. Plant Sci*. 8:2143.

Madhani, P. M. (2010), "The Resource - Based View (RBV): Issues and Perspectives." PACE, A *Journal of Research of Prestige Institute of Management*, 1(1): 43-55.

Mahoney, J. T. (1995). The Management of Resources and the Resource of Management. *Journal of Business Research, 33*: 91-101.

Mahoney, J. T. (2011). A resource-based theory of sustainable rents. *Journal of management*, 27 (6): 651-660.

Mayes, S., Massawe, F. J., Alderson, P. G., Roberts, J. A., Azam-Ali, S. N., & Hermann, M. (2012). The potential for underutilized crops to improve security of food production. *Journal of experimental botany*, *63* (3), 1075-1079.

McCulloch, N. & Ota, M. (2002). Export horticulture and poverty in Kenya. *Institute of Development Studies, Working Paper No. 174.*

McMillan, J.M. & Schumacher, S. (2006). *Research in Education: Evidence- based Inquiry (6th ed).* Boston: Peason Education.

Mengistu, F & Hager, H. (2008). Wild edible fruit species cultural domain, informant species competence and preference in three Districts of Amhara Region, Ethiopia. *Ethnobotany Research & Applications 6*, 487-502.

Mendez, C. D. and Cristobal G. B. (2008). Food, consumption and health. 'La Caixa' Foundation. Barcelona.

Mkonda, M. (2014). Rainfall variability and its Association to the trends of crop production in Mvomero district, Tanzania. *European Scientific Journal*, 10 (20): 1857- 7431.

Modi, M., Modi, A., & Hendriks, S. (2006). Potential role for wild vegetables in household food security: A preliminary case study in KwaZulu-Natal, South. Africa. *Afr. J. Food Agric.Nutr. Dev.* 6, 1–13.

MoFA (2007). Food and agriculture Sector Development policy (FASDEP II). Ministry of food and Agriculture, Accra.

MoFA (2009). Agriculture in Ghana. Facts and Figures. Statistics, Research and Information Directorate (SRID), Ministry of Food and Agriculture, Accra.

MoFA, (2012). Agricultural sector annual progress report. Policy Planning Monitoring and Evaluation Directorate Ministry of Food and Agriculture, Accra.

MoFA, (2013). Agricultural sector annual progress report. Ministry of Food and Agriculture, Accra.

MoFA, (2014). Agricultural sector annual progress report. Monitoring and Evaluation Directorate, Ministry of Food and Agriculture, Accra.

MoFA, (2015). Agricultural sector annual progress report. Monitoring and Evaluation Directorate, Ministry of Food and Agriculture, Accra.

MoFA, (2016). Agricultural sector annual progress report. Monitoring and Evaluation Directorate, Ministry of Food and Agriculture, Accra.

MoFA, (2017). Agricultural sector annual progress report. Ministry of Food and Agriculture, Accra.

Mohan, V. (2004). Why are Indians more prone to diabetes? *Journal Assoc Physicians India.* 52:468 -474.

Moss, G. (2004). Provisions of trustworthiness in critical narrative research: Building Inter subjectivity and fidelity. *The Qualitative Report,* 9 (2):359-374.

Muhammad, Y. Y. (2014) Exploring the potential of bambara groundnut, an underutilized African legume species, towards food security in Africa. *African Journal of Agricultural Science and Technology (AJAST),* 2 (11): 201-204.

Mussa, M., Teka H. & Mesfin, Y. (2017). Land use and cover change analysis and local community perception towards land cover change in the lowland of Bale rangelands, Southeast Ethiopia. *International Journal of Biodiversity and Conservation,* 9 (12):363-372.

Nair, A., Trendowski, J., & Judge, B. (2008). The Theory of the Growth of the Firm, by Edith T. Penrose. Oxford: Blackwell, 1959, *Academy of Management Review*, 33(4), 1026-1028.

Narendhirakannan, R. T., Subramanian, S., & Kandaswamy, M. (2007). Anti-inflammatory and lysosomal stability actions of Cleome gynandra L. studied in adjuvant induced arthritic rats. *Food and Chemical Toxicology*, 45(6):1001-1012.

NDPC (2015). Ghana Millennium Development Goals 2015 Report. National Development Planning Commission, Accra.

Nkari, I. M. & Kibera, F. N. (2016). The influence of farmer characteristics on performance of commercial farmers in Kiambu County, Kenya. *European Journal of Business and Social Sciences,* 5 (3): 63 – 78.

Nyadanu, D. & Aboagye, L. M. (2014). Harnessing plant genetic resources of neglected and underutilized species for nutrition, food security and health in Africa. Book of abstracts, international research initiatives conference.

Nyadanu, D. & Lowor, S. T. (2014). Promoting competitiveness of neglected and underutilized crop species: comparative analysis of nutritional composition of indigenous and exotic leafy and fruit vegetables in Ghana. *Genet Resour Crop Evol,* 61(6).

Nyadanu, D., Aboagye, L. M., & Ahamadou, B. (2014a) Managing risks and uncertainties in agriculture: the role of plant genetic resources of neglected and underutilized crop species in Africa. Book of Abstracts pp 26–27, ANAFE symposium on agribusiness development and managing risk and uncertainties in African agriculture: the role of tertiary agricultural education, Yaounde.

Nyadanu, D., Aboagye, L. M., Akromah, R. & Dansi, A. (2015). Agro-biodiversity and challenges of on-farm conservation: the case of plant genetic resources of neglected and underutilized crop species in Ghana. *Genet Resour Crop Evol.* DOI 10.1007/s10722-015-0327-2.

Nyanteng, V. K. & Asuming-Brempong, S. (2003). The Role of Agriculture in Food Security in Ghana. A paper presented at Roles of Agriculture Project International Conference 20-22 October, 2003 Rome, Italy. Organized by Agricultural and Development Economics Division (ESA) Food and Agriculture Organization of the United Nations.

Obayelu, O. A., Adepoju, A. O., & Idowu, T. (2014). Factors influencing farmers' choices of adaptation to climate change in Ekiti State, Nigeria. *Journal of Agriculture and Environment for International Development*, 108(1), 3-16.

Obi, A. (Ed.) (2011). *Institutional constraints to small farmer development in Southern Africa*. Wageningen Academic Publishers.

Ogbodo E.N & Onwa N.C. (2013). Impact of Long-term Application of Agrochemicals on the Agro-Ecology of the Lower Anambra River Basin Southeast Nigeria. *Journal of Environment and Earth Science.* 3 (5):32-37.

Ogechi, B. A. & Hunja, W. E (2014). Land Use Land Cover Changes and Implications for Food Production: A Case Study of Keumbu Region Kisii County, Kenya.

International Journal of Science and Research, 3 (10):752-758.

Olembo N, M'mboyi, F & Oyugi, K. (2010). Success Stories in Crop Improvement in Africa. The Case of Rice in Sub-Saharan Africa. African Biotechnology Stakeholders Forum (ABSF). Nairobi, Kenya.

Omari, S. (2014). Assessing farmers' knowledge of effects of agrochemical use on human health and the environment: A case study of Akuapem South Municipality, Ghana. *Int. Journal of Applied Sciences and Engineering Research*, 3 (2):402-410. DOI: 10.6088/ijaser.030200010.

Omari R, Quorantsen K. E & Omari P. K (2017). Nutrition knowledge and food consumption practices and barriers in rural Ghana: The case of foods for preventing vitamin a and iron deficiencies. *Afr. J. Food Agric. Nutr. Dev*. 17(1): 11639-11656.

Ouma, E., Jagwe, J., Obare, G. A., & Abele, S. (2010). Determinants of smallholder farmers' participation in banana markets in Central Africa: the role of transaction costs. *Agricultural Economics*, 41: 111–122.

Pablo, A., Reay, T., Dewald, J. & Casebeer, A. (2007). Identifying, enabling and managing dynamic capabilities in the public sector. *Journal of Management Studies*, *44*(5), 687-708.

Padulosi, S., Hodgkin, T. Williams, J. T. & Haq, N. (2002). Under-utilized crops: Trends, challenges and opportunities in the 21st century. In Managing plant genetic resources, ed. Engels, J.M.M et al. London and Rome: CABI-IPGRI.

Padulosi S. & Hoeschle-Zeledon I. (2004). Underutilized plant species: what are they? *LEISA Magazine,* 20 (1): 5-6.

Padulosi, S., Hoeschle-Zeledon, I. & Bordoni, P. (2008) Minor crops and underutilized species: lessons and prospects. In: N Maxted, BV Ford-Lloyd, SP Kell, JM Iriondo, MEDulloo, and J Turok (eds) *CropWild Relatives Conservation and Use*, pp. 605–624 CAB, International, Wallingford, UK.

Padulosi, S., Heywood, V., Hunter, D., & Jarvis, A. (2011). Underutilized species and climate change: Current status and outlook. *Crop adaptation to climate change*, 1, 507-521.

Padulosi, S., Thompson, J., & Rudebjer, P. (2013). *Fighting poverty, hunger and malnutrition with neglected and underutilized species: Needs, challenges and the way forward: Neglected and underutilized species.* Rome, Italy: Biodiversity International.

Pedro, M. R. A. & Benavides R. C. (2006). Dietary Changes and their health implications in the Philippines.

Pesticide Action Network (PAN) Europe (2017). *Alternative method to weed management to the use of glyphosate and otherherbicides.* Rue de la Pacification 67, 1000 Brussels, Belgium.

Rao, R., Kruijssen, F., & Keyu, B. (2005). Socioeconomic factors affecting genetic diversity and genetic erosion on farm. Hydrabad, India.

Sagoe. R. (2006). Climate change and root crop production in Ghana. A report prepared for environmental protection agency (EPA) Accra-Ghana.

Sanchez, R. (2008). A Scientific Critique of the Resource-Base View (RBV) in Strategy Theory, with Competence-Base Remedies for the RBV's Conceptual Deficiencies and Logic Problems. *Research in Competence-Based Management,* Volume 4.

Shackleton, C. M, Pasquini, M.W. & Drescher, A.W. (2009). *African Indigenous Vegetables in Urban Agriculture*; Routledge: New York, USA.

Sharma, R & Bhardwaj, S. (2017). Effect of mulching on soil and water conservation -A review. *Agricultural Reviews*, 38(4): 311-315.

Solh, M. E. (2016). *Importance, challenges and potential of neglected and underutilized crops. FAO regional initiative on zero hunger. Regional consultation on scoping and mapping of neglected and underutilized crop species in Asia.* Bangkok: FAO.

Sprent, J. I., Odee, D. W., & Dakora, F. D. (2009). African legumes: a vital but under-utilized resource. *Journal of Experimental Botany*, 61 (5): 1257–1265.

SPRING (2017). *Good Agronomic Practices for Safe Groundnut Production in Ghana. Video Facilitator's Guide*. Arlington, VA: Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) project. Arlington, USA, 20p.

Stanturf, J. A., Warren, M. L., Charnley, Jr., S., Polasky, S. C., Goodrick, S. L., Armah, F., & Nyako, Y. A. (2011). Ghana Cli-mate Change Vulnerability and Adaptation Assessment. Washington: US Agency for International Development.

Stefanie, E & Amend, T. (2008) Development needs diversity: People, natural resources and International Cooperation – Contributions from the countries of the south. In: *Sustainability Has Many Faces*. (GTZ) Eschborn, Germany.

Steyn N. P., Bradshaw, D., Norman R., Joubert J. D., Schneider M. & Steyn, K. (2006). Dietary changes and the health transition in South Africa: implications for health policy. FAO. Rome.

Sunderland, T. C. H. (2011). Food security: why is biodiversity important? *International Forestry Review*. 13(3):265-274.

Thrupp, L. A. (2000). Linking Agricultural Biodiversity and Food Security: The Valuable role of Sustainable Agriculture. *International Affairs,* 76 (2): 265-281.

Toledo, A. & Burlingame, B. (2006). Biodiversity and nutrition; a common path toward global food security and sustainable development. *Journal of Food Composition and Analysis* 19: 477–483.

Turan, S.Ö. & Günlü, A. (2010) Spatial and temporal dynamics of land use pattern response to urbanization in Kastamonu. *African Journal of Biotechnology*, 9 (5): 640-647.

UNESCAP (2009). *Sustainable agriculture and food security in the Asia Pacific.* Bangkok: UNESCAP.

Wangthamrong, T. (2010). *Food security in Thailand: Hunger in the midst of plenty*. Georgetown University, Washington DC.

Water Resource Commission Ghana (2011). Dayi River Basin integrated water resources management (IWRM) plan. Water Resources Commission Ministry of Water Resources Works and Housing; Accra, 54p.

Watuleke, J. (2014). *From sustainability to sustainable development: the role of food banks in food security in Uganda: a case study of the hunger project food bank-Mbale epicenter*. Spring, Uganda.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal,* 5 (2): 171-180.

WHO (2017). The double burden of malnutrition. Policy brief. Geneva: World Health Organization.

Wildlife Department. (1994). *Kogyae Strict Nature Reserve National Park Management Plan*. Wildlife Division. Accra.

William, P. W., Hoskisson, R. E., Short, J. C. & Yiu, D. W. (2011). Resource-Based Theory and corporate diversification: Accomplishments and opportunities. *Journal of Management*, 37 (5): 1335-1368.

World Food Programme (2009). Comprehensive Food Security & Vulnerability Analysis, Ghana, *World Food Programme*, Rome, Italy.

World Food Programme (2012). Comprehensive Food Security & Vulnerability Analysis: Focus on Northern Ghana; World Food Programme, Rome, Italy.

Wu, L., Xu, Y., 1, Yuan, J., Xu, Y., Wang, Q., Xu, X., & Wen, H. (2018). Impacts of land use change on river systems for a River Network Plain, *Water*, 10, 609, doi:10.3390/w10050609

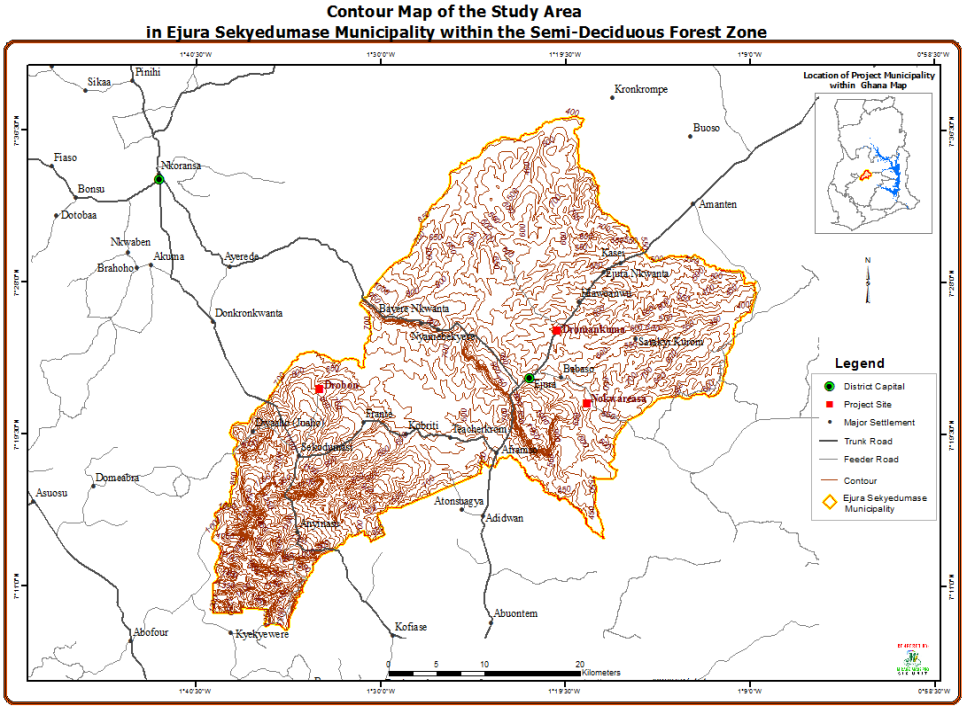
Yaro, J. A. (2010). The Social Dimensions of Adaptation to Cli-mate Change in Ghana. The World Bank Discussion paper no.15. Washington: The World Bank.

Yidana, S. M., Ophori, D., & Benoeng-Yakubu, B. (2008). Hydrological and hydrochemical characterization of the Voltaian Basin: The Afram Plains Area, Ghana. *Environmental Geology,* 53 (6), 1213-1223.

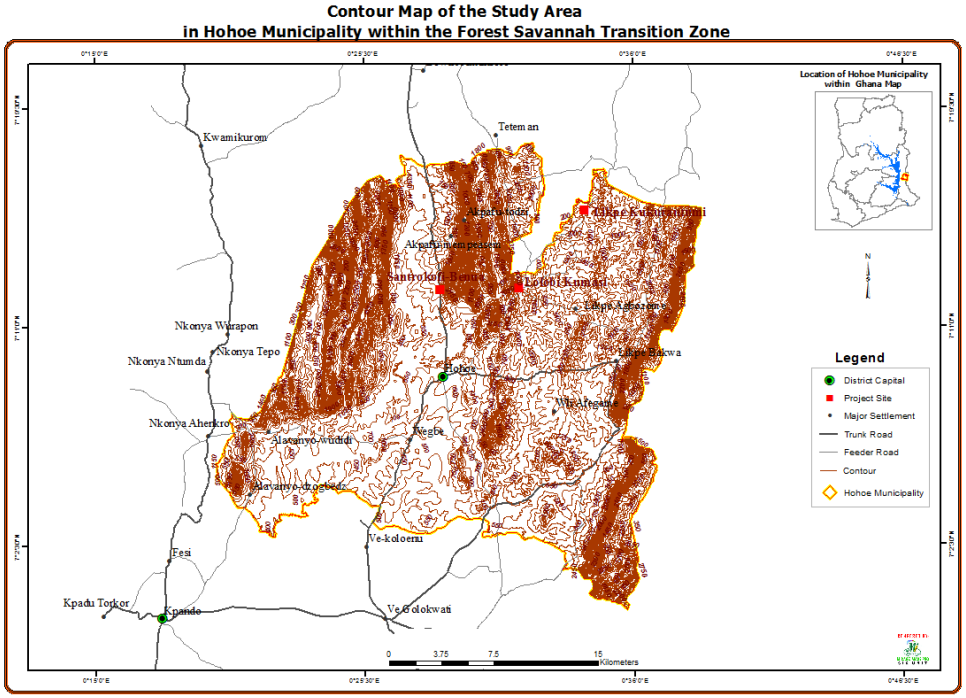
Zakaria S., L. Ying, L., & Song, B. (2014). "Factors Influencing Household Food Security. The Case of Southern Niger." *Sustainability*, 119-120.

APPENDIX

Appendix A: Contour Map of Ejura within Upper Afram basin



Appendix B: Contour Map of Hohoe within Upper Dayi basin



Appendix C: **Accuracy Assessment Table based on Error Matrix of the Pixel-based method – Ejura Sekyedumase (Upper Afram Basin) 2018 Classified Image**

Classes	Closed canopy	Open canopy	Dense shrub	Grass/ herb	Bare/built	Water body	**Total**
Closed canopy	17	2	1				20
Open canopy	1	16	1	1			19
Dense shrub	1	2	15	1			19
Grass/herb			1	15	1		17
Bare /built				1	14	1	16
Water body						9	9
Total	**19**	**20**	**18**	**18**	**15**	**10**	**100**

From the above error matrix:

The number of correctly classified site: 17 + 16 + 15 + 15 + 14 + 9 = 86, Total number of reference sites = 100

Therefore, the Overall Accuracy = 86/100 = 86%

Kappa

$$\hat{K} = \frac{N\sum_{i=1}^{k} x_{ii} - \sum_{i=1}^{k} x_{i+}x_{+i}}{N^2 - \sum_{i=1}^{k} x_{i+}x_{+i}}$$

$$K = \frac{100(17+16+15+15+14+9) - (19*20+20*19+18*19+18*17+15*16+10*9)}{100^2 - (19*20+20*19+18*19+18*17+15*16+10*9)}$$

$$K = \frac{100(86) - (1738)}{10000 - (1738)}$$

$$K = \frac{8600 - (1738)}{10000 - (1738)}$$

$$K = \frac{6862}{8262}$$

$$K = 0.8305$$

Appendix D: **Accuracy Assessment Table based on Error Matrix of the Pixel-based method – Hohoe (Upper Dayi Basin) 2018 Classified Image**

Classes	Closed canopy	Open canopy	Dense shrub	Grass/ herb	Bare/built	**Total**
Closed canopy	17	2				19
Open canopy	1	16				17
Dense shrub	1	1	15	1		18
Grass/herb			2	13	2	17
Bare /built				2	12	14
Total	**19**	**19**	**17**	**16**	**14**	**85**

From the above error matrix:

The number of correctly classified site: 17 + 16 + 15 + 13 + 12 = 73, Total number of reference sites = 85

Therefore, the Overall Accuracy = 73/85 = 85.88

Kappa

$$\hat{K} = \frac{N\sum_{i=1}^{k} x_{ii} - \sum_{i=1}^{k} x_{i+}x_{+i}}{N^2 - \sum_{i=1}^{k} x_{i+}x_{+i}}$$

$$K = \frac{85(17+16+15+13+12) - (19*19+17*19+18*17+17*16+14*14)}{85^2 - (19*19+17*19+18*17+17*16+14*14)}$$

$$K = \frac{85(73) - (1458)}{7225 - (1458)}$$

$$K = \frac{6205 - (1458)}{7225 - (1458)}$$

$$K = \frac{4747}{5767}$$

$$K = 0.8231$$

Appendic E: **SEMI-STRUCTURED QUESTIONNAIRE FOR FARMERS**

Neglected and Underutilized Crop Species (NUCS) and Household Food Security in Central Ghana

Dear Respondent,

I am a PhD student of the Institute of Environment & Sanitation Studies of the University of Ghana carrying out a research on **neglected and Underutilized crop and plant species** in Ghana. The aim of this study is to investigate and examine the drivers that influence these crops in Central Ghana with the view to encouraging their use in addressing household food insecurity in Ghana. This discussion is intended to elicit information purely for academic purposes and will be treated with the highest degree of confidentiality. You are therefore encouraged to be as objective as possible in your responses.

Section A:

i. Date of interview: __ __ / __ __ / 2018

ii. Start time: ……. : ……

iii. Name of interviewer: .....

1. Name of community : .....
2. District : ..... (provide districts)
3. Name of respondent : .....
4. Sex of respondent 1. Male 2. Female
5. Location of respondent's house: .....
   .....
6. Origin 1. Indigene 2. Settler
7. Length of stay in community: ……

Section B: Household Composition and Education

MID	Member's name	Sex	Age	Relationship to head of household	Marital status	Religious denomination	Ethnicity	Highest educational qualification	Currently attending school?	Current occupation	
										Primary	Secondary
		1.Male 2.Female		1. Head 2. Spouse 3. Son/Daughter 4. Parent / parent-in-law 5. Son/Daughter-in-law 6.Other relative 7. Non relative	1.Never married 2.Married 3.Widow/widower 4.Divorced 5.Separated 6.Co-habiting	1.Christian 2.Muslim 3.Traditional 4. None	1.Akan 2.Ewe 3.Ga-Dangme 4.Guan 5. Mole Dagbani 6.Others	1. None 2. Primary 3.JHS/JSS/MSLC 4.SHS/SSS/O'Level/A'Level 5.Voca/Comm 6.Training College 7.Degree/HND 8.Tech/Prof. Cert 9.Other (specify)	1.Yes 2.No	1.Crop/vegetable farming 2.Livestock/poultry farming 3.Fishing 4.Trading 5.Artisan 6.Civil/Public servant 7.Other professional work 8.Student/Apprentice 9.Unemployed 10.Household/domestic work 11. Retired 12. Other (specify)	
B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11a	B11b

C. Food crops cultivation in community

C1. List all ***crops / vegetables*** currently cultivated by farmers in this community. Use local names

i. ……..……
ii. ……..…..
iii. ……..….
iv. ……..….
v. ……..…..
vi. ……..…..
vii. ……..
viii. …….
ix. ……..
x. ……..….
xi. ……..…
xii. ……

C2. List all ***crops / vegetables*** which were cultivated by farmers in this community about 10 years ago but are not currently produced in this community.

i. ……..……
ii. ……..…..
iii. ……..….
iv. ……..….
v. ……..…..
vi. ……..…..
vii. ……..
viii. …….
ix. ……..
x. ……..….
xi. ……..…
xii. ……

C3. What do you think is bringing about this change in crops grown?

i. ……..……
ii. ……..…..
iii. ……..….
iv. ……..….
v. ……..…..
vi. ……..…..
vii. ……..
viii. …….
ix. ……..
x. ……..….
xi. ……..…
xii. ……
xiii. ……

C4. List some crops / plants considered to be '***less utilized crops***' in this community

i. ……..……
ii. ……..…..
iii. ……..….
iv. ……..….
v. ……..…..
vi. ……..…..
vii. ……..
viii. …….
ix. ……..
x. ……..….
xi. ……..…
xii. ……

C5. What do you think are some benefits of underutilized crops? ***(Select and rank all that apply)***

1. Poverty alleviation
2. Soil fertility
3. Biodiversity conservation
4. Additional income
5. Food security
6. Balance diet
7. Job opportunity
8. Religious and cultural values
9. Other (specify) ……..

D. Farming Systems

	CODES	Farm 1	Farm 2	Farm 3
D1. What is the size of this farm? Unit code for farm size	1.Acre 2 Plot. 3. Hectare			
D2. Is the plot owned by the household?	1. Yes, with deed (title) 2. Yes, without deed (title) 3. No			
D3. How was the plot obtained?	1. Purchased 2. Rented for cash/in-kind 3. Sharecropped by household 4. Use free of charge 5. Inherited (Distributed by village / family)			
D4. What is the annual rent? *Let the respondent value any in-kind payment and include it.*				
D5. What proportion of crops goes to the landlord?	Fraction or Percentage			
D6. Has this plot ever been left to fallow since you obtained it or started using it?	1. Yes 2. No (>> D8)			
D7. How long was it left to fallow? In years				
D8. Have you changed your crops or cropping pattern over the past 10 years on this farm?	1. Yes 2. No (>> D10)			
D9. Why did you adapt these changes?				
D10. If **no**, what makes you continue to grow the crops you have been growing for so long?				

E. Knowledge and use of less utilized crops

E1. Name of less utilized crop cultivated by farmer (specific variety / specie)	CODES	1.	2.	3.	4.	5.	6.	7.	8.
E2. Which crop family / group does this variety / specie belong to?	Cereal, legume, root/tuber, etc								
E3. What is the common local name(s) used for this crop?									
E4. Which part (s) is usually used for food?	1. Root 2. Stem 3. Leaves 4. Fruit 5. Seeds 6. Other (specify)								
E5. Which part (s) is usually used for other purposes?	1. Root 2. Stem 3. Leaves 4. Fruit 5. Seeds 6. Other (specify)								
E6. What are the common local uses of this crop / plant? *List them*									
E7. Which of the following factors significantly influence the cultivation of this crop? ***(Circle all that apply)***	1. Rainfall 2. Temperature 3. Humidity 4. Ecological zone 5. Soil type								
E8. Does your household consume this crop?	1. Yes 2. No								
E9. Are there any cultural beliefs for consuming/cultivating this crop	1. Yes 2. No								

E1. Name of less utilized crop cultivated by farmer (specific variety / specie)	CODES	1.	2.	3.	4.	5.	6.	7.	8.
/ plant?									
E10. Please, outline these cultural beliefs									
E11. Does your household always get enough of this crop / plant to consume?	1. Yes 2. No								
E12. What accounts for the shortage? 1. Does not produce enough 2. Don't have money to buy it 3. Not available in this community 4. Other (specify) ……..									
E13. Which age groups can consume this crop / plant? ***(Select all that apply)***	1. 10 years or less 2. 11 – 18 years 3. 19 – 50 years 4. 51 and older								
E14. Are there any cultural / social reasons why some age groups do not consume this crop / plant?	1. Yes 2. No (>> E16)								
E15. Please, outline these reasons									
E16. Do both men and women consume this crop / plant?	1. Yes, both (>>E19) 2. No, men only 3. No, women only								
E17. Are there any reasons for this?	1. Yes 2. No								

E1. Name of less utilized crop cultivated by farmer (specific variety / specie)	CODES	1.	2.	3.	4.	5.	6.	7.	8.
E18. Please, outline these reasons									
E19. What reasons account for its consumption?	1. Taste 2. Health (Nutrition) 3. Cultural believes 4. Other (specify)								
E20. If **NO to E8**, do you have any reasons for not consuming this crop / plant?	1. Yes 2. No (>> E22)								
E21. Please, outline these reasons									
E22. Which age groups usually cultivate this crop / plant? ***(Select all that apply)***	1. 18 – 35 years 2. 36 – 50 years 3. 51 years and older 4. All age groups								
E23. Are there any reasons why not all age groups cultivate this crop / plant?	1. Yes 2. No								
E24. Please, outline these reasons.									
E25. What are the various methods of preparation for consumption? ***(Select all that apply)***	1. Eaten fresh 2. Boiling 3. Frying 4. Roasting 5. Steaming 6. Other (specify)								

E1. Name of less utilized crop cultivated by farmer (specific variety / specie)	CODES	1.	2.	3.	4.	5.	6.	7.	8.
E26. Do you occasionally collect / harvest this crop from the wild?	1. Yes 2. No								
On a scale of 1 – 5, rank the following attributes on how you like it:									
E27. Appearance									
E28. Aroma									
E29. Texture									
E30. Sweetness									
E31. Non-perishability									
E32. Has the household ever cultivated this crop / plant?	1. Yes 2. No (>> E38)								
E33. Does the household still cultivate this crop / plant?	1. Yes (>> E36) 2. No								
E34. Why has the household stopped cultivating this crop / plant?									
E35. When was the last time a household member cultivated this crop / plant? ***Specify year***									
E36. Why does the household cultivate this crop? 1. Mainly for household food consumption 2. Mainly for income 3. Cultural reasons 4. For medicinal purposes 5. Other (specify) …….									
E37. What role does this crop / plant play in terms of the livelihood									

E1. Name of less utilized crop cultivated by farmer (specific variety / specie)	CODES	1.	2.	3.	4.	5.	6.	7.	8.
of household members?									
E38. Do you think cultural activities in this area promote the use of this crop / plant in this community?	1. Yes 2. No								
E39. Please explain your answer and give some specific examples to support your answer.									
E40. On how many acres of land was this crop cultivated in the last farming season?									
E41. What quantity of crop was harvested in the last 12 months?									
E42. Unit of measurement 1. Kilogram 2. American tin 3. Basket 4. Maxi bag 5. Mini bag 6. Tubers 7. Singles 8. Bowl 9. Fingers 10. Box 11. Bundle 12. Gallon 13. Litre 14. Beer bottle 15. Crate 16. Carton 17. Pieces 18. Nuts 19. Margarine tin 20. Fruits 21. Other (specify)									
E43. Did you sell any of your harvest?	1. Yes 2. No								

E1. Name of less utilized crop cultivated by farmer (specific variety / specie)	CODES	1.	2.	3.	4.	5.	6.	7.	8.
E44. In total, how much of crop harvested was sold?									
E45. Where was the crop mainly sold?	1. Farm-gate, after harvesting 2. On farm, before harvesting 3. Community market 4. District market 5. Other (specify)								
F46. Do you have ready market for this crop / plant produced in your farm?	1. Yes 2. No								
E47. Do middlemen come to this community to buy this crop / plant?	1. Yes 2. No								
E48. Do middlemen come to this community to buy other agricultural produce?	1. Yes 2. No								
E49. Do other community members buy this crop / plant from you?	1. Yes 2. No								
E50. Does the income from this crop / plant constitute a primary income source for your household?	1. Yes 2. No								
E51. Did the household consume any own production of this crop?	1. Yes 2. No	1. 2.							
E52. How often do you consume this crop / plant?	1. Very often 2. Often 3. Rarely								
E53. Is this crop / plant used in the preparation of the main meal in the house at least twice in a week?	1. Yes 2. No								

E1. Name of less utilized crop cultivated by farmer (specific variety / specie)	CODES	1.	2.	3.	4.	5.	6.	7.	8.
E54. Have you ever cultivated this crop / plant with the intention of earning income from it?	1. Yes 2. No								
E55. The last time you cultivated this crop / plant with commercial intention did you earn enough income from it?	1. Yes 2. No								
E56. Do you have some of this crop in store?	1. Yes 2. No								
E57. How is this crop / plant preserved?									
E58. How is this crop propagated?									
E59. Do you think such propagation knowledge systems are being lost or vanishing? Explain									
E60. Are there any difficulties in propagating and conserving the crop? Explain									
E61. Did you use any fertilizer on this plot?	1. Yes 2. No								
E62. Name of main fertilizer used.									
E63. Total quantity of fertilizer used									
E64. Unit code	1. Kilogram 2. Litres 3. Bucket 4. American tin 5. Other								

E1. Name of less utilized crop cultivated by farmer (specific variety / specie)	CODES	1.	2.	3.	4.	5.	6.	7.	8.
	(specify)								
E65. Total cost/value of fertilizer used.									
E66. How did you obtain the fertilizer? 1. Purchased 2. Distributed freely by government 3. Distributed freely by an NGO 4. Distributed freely by cooperative / association 5. Other (specify)									
E67. Is this land fertile / appropriate for cultivating this crop / plant on it?	1. Yes 2. No								
E68. Did you use any herbicide / weedicide on the plot where this crop is planted?	1. Yes 2. No (>>E81)								
E69. Name of herbicide / weedicide.									
E70. Total quantity of herbicide / weedicide used.									
E71. Unit code									
E72. Total cost/value of herbicide / weedicide used.									
E73. How did you obtain the herbicide / weedicide? 1. Purchased 2. Distributed freely by government 3. Distributed freely by an NGO 4. Distributed freely by cooperative / association 5. Other (specify)									
E74. Did you use any pesticides on this crop?	1. Yes 2. No								
E75. Name of pesticide used.									

E1. Name of less utilized crop cultivated by farmer (specific variety / specie)	CODES	1.	2.	3.	4.	5.	6.	7.	8.
E76. Total quantity of pesticides used.									
E77. Unit code	1. Kilogram 2. Litres 3. Bucket 4. American tin 5. Other (specify)								
E78. Total cost/value of pesticides used.									
E79. How did you obtain the pesticides? 1. Purchased 2. Distributed freely by government 3. Distributed freely by an NGO 4. Distributed freely by cooperative / association 5. Other (specify)									
E80. Do you use any modern technology in cultivating this crop / plant?	1. Yes 2. No								
E81. Kindly, enumerate these technologies?									
E82. In your view, which of these are hindering the cultivation or promotion of this crop / plant? ***(Select all that applies)*** 1. labour-intensive and time-consuming methods of cultivation 2. unavailability of efficient technologies 3. seed and harvest loses									

E1. Name of less utilized crop cultivated by farmer (specific variety / specie)	CODES	1.	2.	3.	4.	5.	6.	7.	8.
4. no attention to genetic improvement and production management 5. propagation difficulties 6. low productivity 7. limited water resources 8. lack of domestication 9. mono-cropping 10. lack of attractive varieties 11. limited geographical coverage 12. Other (specify)									
E83. Have you received any specific cropping information on this crop / plant from an agric. extension officer?	1. Yes **2.** No **[Go to next Crop]**								
E84. Which information did you receive from the agric. Extension officer?									
E85. How many times did the agric. extension officer visit you in the past 1 year?	1. None 2. Once 3. Twice 4. Thrice 5. 4 times or more **[Go to next crop]**								

F. Environmental issues

	a. Did the household experience any … in the last 12 months? **1. Yes 2. No**	**b. How did the household cope with this disaster?**
1. Flood		
2. Bushfire		
3. Attack of insects / pests		
4. Other (specify)		

G. Household food security

G1. How many months in the year is your household able to adequately feed itself?

G2. Which months in the year does the household buy food to supplement household food production?

Jan 2. Feb 3. Mar 4. Apr 5. May 6. Jun
7. Jul 8. Aug 9. Sep 10. Oct 11. Nov 12. Dec

G3. Which of the following statements best describes the food eaten in your household currently?

1. We always had enough food to eat and ate the kind of food we wanted.
2. We had enough to eat BUT not always the kind of food we wanted.
3. We sometimes didn't have enough to eat.
4. We often didn't have enough to eat.

G4. If your household currently cannot adequately feed itself throughout the year, what are the three (3) main reasons responsible for this?

A. Drought
B. Crops damage due to pests or diseases
C. Small farm size due to inadequate access to farmland
D. Small farm size due to inability to acquire adequate seeds
E. Small farm size due to inability to acquire adequate fertilizer
F. Small farm size due to inability to acquire adequate labour
G. Small farm size due to inability to acquire adequate other inputs
H. Poor yield due to poor soil
I. Poor yield due to poor seeds
J. Loss of crops due to excessive rain/flooding
K. Loss of crop due to bushfires
L. Inability to purchase food to supplement own production
M. Sold most of the harvest to meet other household needs
N. Other (specify) …….

1st 2nd 3rd

G5. In what type of dwelling does the household live?

1. Separate house (Bungalow)
2. Semi-detached house
3. Flat/Apartment
4. Compound House
5. Other (specify) ……

G6. What is the present occupancy status?

1. Owner occupied
2. Renting
3. Rent-free
4. Other (specify)

…….

G7. If the household is renting the dwelling place, what is the annual rent?

GH¢__ __ __ __.__ __

ii. In situations where the household cannot produce enough food to feed itself, can the household achieve food security?

	1. Yes **2. No**	**If "yes", indicate the frequency of occurrence** **1. Everyday** **2. At least once in week** **3. At least once in month** **4. Once or twice in every three months** **5. Once in every six months** **6. Once in a year**
G8. In the last 12 months, did you or other adults in your household **ever cut the size of your meals or skip meals** because there wasn't enough money for food?		
G9. In the last 12 months, did you or other adults in your household **ever eat less nutritious food** because there wasn't enough money for food?		
G10. In the last 12 months, did you other adults in your household **ever not eat for a whole day** because there wasn't enough money for food?		
G11. In the last 12 months, did you **ever cut the size of any of the children's meals** because there wasn't enough money for food?		
G12. In the last 12 months, did any of the **children ever skipped meals** because there wasn't enough money for food?		
G13. In the last 12 months, did any of the **children in your household ever not eat for a whole day** because there wasn't enough money for food?		
G14. In the last 12 months, did any of the children in your household **ever eat less nutritious food** because there wasn't enough money for food?		

H. Household income and expenditure

H1. What is the estimated income of your household?

Income source	**Estimated monthly income**	**Estimated annual income**
Crop farming		
Livestock farming		
Fishing		
Paid employment		
Remittances received		
Sale of assets		
Gain from lottery		
Income from household non-farm enterprise (net)		
Other income source *(specify)* ……		

H2. What is the estimated expenditure of your household?

Expenditure	**Estimated monthly expenditure**	**Estimated yearly expenditure**
Food		
Clothing and housing		
Farming		
Education		
Transportation		
Health		
Donations		
Other expenditure *(specify)* ……		

Interview end time: …….

Thank you.

Appendic F: **FOCUS GROUP DISCUSSION FOR FARMERS**

Neglected and Underutilized Crop Species (NUCS) and Household Food Security in Central Ghana

1. What are the common crops currently cultivated in this community?
2. What crop species were previously cultivated that are no longer under cultivation?
3. What do you think are some benefits of underutilized crops?
4. Why are these crop species no longer cultivated?
5. Can you comment on the effect of market dynamics on the sale of these marginalized crops?
6. Do you think gender plays a role in the promotion of underutilized crops? How?
7. Do you think the promotion of underutilized crops can help address household food security? How?
8. What has been the consumption pattern for these underutilized crops? I. e. season, age, gender, economic status, medical, religion and culture?
9. Do you think changing food consumption patterns/dietary habits could be responsible for the marginalization of some of the local crop varieties?
10. What agronomic practices or farming systems are prevalent in this community and how do these practices affect the cultivation of crops especially underutilized crops?
11. Can you list some factors that influence the cultivation and production of underutilized crops in this town?
12. How would you explain the impact of the climate change phenomenon on the cultivation of these crops?
13. Can you give me a brief history of agricultural pattern in this area?
14. Would you say land use change/types and soil suitability are significant factors affecting the cultivation of underutilized crops in the district? Explain
15. Can you comment on agrochemical use in this community?

Appendix G **INTERVIEW GUIDE FOR DISTRICT DIRECTOR, MoFA**

Neglected and Underutilized Crop Species (NUCS) and Household Food Security in Central Ghana

1. How will you explain the term 'underutilized crops'? Examples, benefits etc.
2. What do you think are the reasons why these crops/species are not widely used?
3. Are you aware of any past survey or study on underutilized crops in the district? If yes explain.
4. Do you think changing food consumption patterns/dietary habits could be responsible for the marginalization of some of the local crop varieties?
5. Are you aware of any specific or comprehensive policy to protect and conserve underutilised crops in Ghana? If no, can you indicate if the country is in the process of developing one?
6. Can you list some of the factors that influence the cultivation and production of underutilized crops in the district?
7. How would you explain the impact of the climate change phenomenon on the cultivation of these crops in Ghana and your district?
8. Would you say land use change/types and soil suitability are significant factors affecting the cultivation of underutilized crops in the district? Explain
9. Can you comment on agrochemical use among farmers in the district?
10. How would you explain household food security and the current state of food security in the district?
11. Would you say that the promotion of underutilized crops can help address household food insecurity?
12. How would you describe marketing and consumption patterns among the different age groups in the district on the utilisation of these crops?

Appendix H: INTERVIEW GUIDE FOR MoFA EXTENSION OFFICERS

Neglected and Underutilized Crop Species (NUCS) and Household Food Security in Central Ghana

1. How will you explain the term 'underutilized crops'? Examples, benefits etc.
2. What do you think are the reasons why these crops/species are not widely used?
3. Are you aware of any past survey or study on underutilized crops in the district? If yes explain.
4. List some of the traditional/common crops currently cultivated and those that are no longer under cultivation in the district?
5. Can you comment on the effect of market dynamics on the sale of these marginalized crops?
6. Give a brief history of the pattern of agricultural food production. List some of the agronomic practices that are prevalent among farmers in the town and how these practices are affecting the cultivation of crops especially underutilized crops.
7. Describe the common farming systems in the district and their impact on agricultural production especially the cultivation of underutilised crops.
8. What type of assistance do you provide to the farmers, frequency of visits etc?
9. Can you list some of the factors that influence the cultivation and production of underutilized crops in the district?
10. How would you explain the impact of the climate change phenomenon on the cultivation of these crops in Ghana and your district?
11. Would you say land use change/types and soil suitability are significant factors affecting the cultivation of underutilized crops in the district? Explain
12. Can you comment on agrochemical use among farmers in the district?
13. Would you say that the promotion of underutilized crops can help address household food insecurity?

Appendix I **INTERVIEW GUIDE FOR I. FIELD/RESEARCH OFFICER, CROP RESEARCH INSTITUTE II. FIELD/RESEARCH OFFICER, AGRICULTURAL FBA/CSO**

Neglected and Underutilized Crop Species (NUCS) and Household Food Security in Central Ghana

1. How will you explain the term 'underutilized crops'? Examples, benefits etc.
2. What do you think are the reasons why these crops/species are not widely used?
3. Are you aware of any past survey or study on underutilized crops in the district? If yes explain.
4. Have you participated in any research study on underutilised crops before? Would you say such a study is important, why?
5. Do you think changing food consumption patterns/dietary habits could be responsible for the marginalization of some of the local crop varieties?
6. Do you know of any article or research that has been published on underutilised crops in Ghana?
7. Are you aware of any specific or comprehensive policy to protect and conserve underutilised crops in Ghana? If no, can you indicate if the country is in the process of developing one? Do you see the need for one in the country?
8. What agronomic practices or farming systems are prevalent among farmers in the district and how do these practices affect the cultivation of crops especially underutilized crops?
9. Can you list some factors that influence the cultivation and production of underutilized crops in the district?
10. How would you explain the impact of the climate change phenomenon on the cultivation of these crops in Ghana and your district?
11. Would you say land use change/types and soil suitability are significant factors affecting the cultivation of underutilized crops in the district? Explain
12. Can you comment on agrochemical use among farmers in the district?
13. How would you explain household food security and the current state of food security in the district?
14. Would you say that the promotion of underutilized crops can help address household food insecurity?

Appendix J **INTERVIEW GUIDE FOR SELLERS FROM SELECTED MARKETS IN THE DISTRICT**

1. What are the main food crops sold on the market?
2. Kindly list some of the crops considered to be marginalized or underutilized in this town/community?
3. Which of them do you sell and in what quantity?
4. How do you obtain these crops that that you consider marginalized? Eg. farm-gate, middle men, etc
5. What do you think are some benefits of underutilized crops?
6. How has the market for these crops been like?
7. Can you comment on the effect of market dynamics on the sale of these marginalized crops?
8. Do you think changing food consumption patterns/dietary habits could be responsible for the marginalization of some of the local crop varieties?
9. What do you think are the reasons why these crops/species are not widely used?
10. Do you think the promotion of underutilized crops can help address household food security?
11. Do you think gender plays a role in the promotion of underutilized crops? How?
12. What role does market play in the promotion of underutilized crops?
13. What has been the consumption pattern for these underutilized crops? I. e. season, age, gender, economic status, medical, religion and culture?