THE POTENTIAL OF AGROFORESTRY IN REDUCING THE EFFECTS OF CLIMATE VARIABILITY ON FOOD SECURITY AMONG WOMEN IN THE JAMAN NORTH

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JUNE 2018
DECLARATION

I do hereby declare that this research work is the result of my own original research and has not been presented by me or any other person for another degree in this or another university. All references used in this work have been fully acknowledged.

I bear sole responsibility for any shortcomings in this work.

MARY INA BOAKYE YIADOM (10636889)
CERTIFICATION

I do hereby declare that the preparation and presentation of the work was supervised by me in accordance with the guidelines laid down by the University.

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DEDICATION

I dedicate this project work to God almighty for such an undeserving grace. My profound gratitude goes to my mother Philomena Boakye and my other siblings, family and friends who have supported in both in prayer, kind and cash. Again my sincere thanks go to my former boss Mr. Collins Yaw Faakye for the helping hand he extended to me when I needed it most. May God reward you all greatly, for your love and support.
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To you all, I say God richly bless you, NYAME NHYIRA MO OOO.
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## ABSTRACT
The impact of climate change on agriculture has become an important issue for government in developed and developing countries. This research examined the potential of agroforestry in reducing the effects of climate variability on food security among women in the Jaman north. The study sought to investigate the roles of women in agricultural production and on food security, assessed the coping strategies adopted by women to mitigate the impacts of exposure from climate change and examine the role of agroforestry practices in improving women adaptability to the exposure to climate-related hazards. To achieve the objectives of the study mixed method research, a convenient sampling technique were used to collect primary data from hundred respondents from five villages in Jaman District. The study found that women in agriculture manage their farms, provide irrigation and manure to the farm, and serve as supervise and participating in post-harvest operations on other people’s farms. Despite the family constrains, women continue farming to ensure food security. Again, women in agriculture conserve water by digging hand dug wells, use irrigation systems, and cultivate drought tolerant crops in order to cope with exposure to climate change hazard. The study recommended that men, as a social responsibility must support their wives, financial and non-financially in their agricultural production. Again, government and rural authorities must prove support and legal protection for the women in Agriculture. Community farming associations can be instituted to help formalise paid labour activities of vulnerable farmers who are adopting it as a strategy to deal with climate change shock. Lastly, women should be encouraged adopt alternative activities such as animal rearing and tree planting to supplement their income and respond positively to the shocks of climate variability.
CHAPTER ONE

1.0 INTRODUCTION

Predictions on climate change indicate that climate variability would eventually bring about a rise in unforeseen rainfall, high temperature, as well as a rise in the harshness and occurrence of severe climatic events (Anold, 1990). Such variations are notably projected to lower agricultural efficiency in the less developed countries (Bails, Ezzati & Kammen, 2005). In the Sub-Saharan Africa, majority of women are into subsistence farming and as such are unable to cope with such climate related hazards due to the challenges associated.

This stems from the fact that they lack the capital to put in innovative and adaptive practices with which to secure their communities and families (Brouwer, 1997). Principally, receptive to climate changes are the households that depend more or less on rain-fed agriculture in improving their survival. Lately, there has been a move to cater for the global development community and research on techniques to assist farmers decrease their exposure to climate change (Bryce, Coitinho Darnton-Hill, 2008).

Agroforestry is recommended as one credible approach for assisting farmers in decreasing their exposure to climate change. Also there is recommendation through research that integration of plants and crops in farming enhances farmer well-being and thereby increasing farm efficiency and income. Nonetheless, there are little research that explicitly examine agroforestry approaches that can decrease the exposure to climate variability (FAO, 2013).

Agroforestry is defined as the combination of trees with animal crop farming. Agroforestry is therefore a sequence of land management approaches undertaken by several people globally. Combination of tress, crops and animals increases farm yield when the various mechanism stake up corresponding
attractions and their association are handled successfully (Steffan-Dewenter, Kessler, Barkmann… Guhardja, 2007). The agroforestry components vary from open lands, to intense imitation of tropical rainforests including backyard farms, to cultivated combination of only a few species, to trees cultivated in hedges or on limitations of farms, with contradictory levels of human supervision of the diverse systems.

Integration of trees, crops and animals is noted to offer a mixture of yield and services that are significant the local level, national level and worldwide (Garrity, 2006) but their position is not at all times completely recognized in development discourse and practices, reflecting the complex to evaluate varied pathways through which trees influence people’s survival. Situations where women are incapable to pay for the high cost innovations that technology brings due to harsh cash and credit difficulties sometimes favour reasonably low-input agricultural choices in relation to tress and crop cultivation (Kiptot & Franzel, 2012).

It is suggested by research that several agroforestry discussions assess the long term effects of agricultural lands that are well managed in blocks, whereas fairly little studies examine agroforestry farms in relation to development projects. Such regulated farm projects permit farmers to decide the sort of agroforestry approaches to use and depend on farmers to change the approaches to correspond with their requirements.

Among the current world food cost increases, climate change issues, as well as challenges of an increasing global increase in population, the function of agriculture in sustaining food accessibility and nutrition have reignited the debate in politics and development discourse. To add to the background for the on-going discussions to the significance of possible interventions of
agroforestry to food safety or availability at all times, this thesis examines the potential of agroforestry in reducing the effects of climate change on food availability among women in Jaman North district. With the study focus on Jaman North in Ghana, the study will investigate the potential of agroforestry in reducing the effects of climate change on food safety among women.

1.1 PROBLEM STATEMENT

Impacts of climate change on agriculture differ by crop, across geographical locations, and seasons, but the total impact is negative cumulatively. Climate change affects agriculture by destroying crops through prolonged drought and flooding. Consequently, unresolved climate change challenges could lead to other harm in the future. Although farming is extremely exposed to climate change, it is obvious that farming activities also influence climate change impacts. The cultivation of rice and soy as well as rearing of farm animals to land use changes as a result of fertilizer use, the farming activity is itself an important push of carbon and non-carbon gases production into the ecosystem.

While the average temperature on agriculture inter-linkages creates difficult overburden and interconnected challenges, the essence of increasing food security and farmers’ livelihoods in the rural areas and also adapting favourably to climate change and mitigation strategies are in no way jointly restricted. There is therefore a necessity engaging in agroforestry as one kind of climate smart agriculture in improving and understanding agricultural systems to increase food security under the current realities of climate variability (Liper, Thornton, Campbell…Hottle, 2014).

It is discussed in literature and also evident in society that women have significant role in all stages of the food production in all regions although such roles and level of participation vary by region. Irrespective of the substantial
contribution of women to agriculture and food and also to nutritional security, women are often systematically disadvantaged and their contributions under-valued. For certain instances, women have less assets and capital to help them make better arrangements for and potentially prevent crises from climate change. Barriers such as availability of land for women use, monetary assistance, communal support as well as availability of credit to women including technology exposes women to food insecurity due to their weak resilience (Dankelman, 2010). This often leads to women having lower coping capacity.

Another problem is the experience of many women in rural areas on the issue of inadequate time to venture into other vocations aside performing the household chores. The capability of persons to take on other useful activities such as education that is contained by time exhausted on menial chores. The collection of wood and water collection is chiefly made by women and young girls who need to walk for long distances, leading to their limited time to engage in other productive activities.

By limiting women’s time to domestic activities it’s bound to have cumulative effects on food security in future since women would have less time to engage in agricultural activities. From the aforementioned, the study therefore seeks to investigate the potential of agroforestry in reducing the effects of climate change on food safety among women with the focus on Jaman North district which is among the farming communities incorporating agroforestry into their agricultural activities.
1.2 GENERAL OBJECTIVES

1.2.1 General Objective

The general objective of the study is to examine the linkage between integrating trees with crops and the effects on food security; on agriculture production as far as women in Jaman North are concerned.

1.2.2 Specific Objectives

The study seeks;

a. To investigate the roles of women in agricultural production and on food security.

b. To assess the coping strategies adopted by women in Jaman North district to mitigate the impacts emanating from exposure from climate change.

c. To examine the role of agroforestry practices in improving women adaptability to the exposure to climate-related hazards in the Jaman North district.

1.3 RESEARCH QUESTIONS

1.3.1 General research questions

What is the linkage between trees integration into crop farming and the effects on food security as far as women in Jaman North are concerned?

1.3.2 Specific research questions

a. What are the roles of women in agricultural production and the impacts of their roles on agriculture and food security?

b. What strategies have been adopted by women in Jaman North to cope with the impacts emanating from exposure from climate change?

c. What is the role of agroforestry practices in improving women adaptability to exposure to climate-related hazards in the Jaman North district?
1.4 SIGNIFICANCE OF THE STUDY

The study seeks to add up to the body of knowledge in the course of the study and also to draw stakeholders’ attention to future agricultural policies particularly in relation to climate change. Further, the study also seeks to understand how farmer-managed agroforestry initiatives has influenced farmers especially women’s well-being in the face of climate related hazards.

1.5 ENVISAGED LIMITATION OF THE STUDY

Distance in travelling from Accra to the study area that is Jaman North district will unequivocally pose a challenge considering the financial cost and the travelling risk associated with it and this will be no different from accommodation issues.

1.6 Organisation of the Study

The study is organised into five chapters. Chapter presents the background information, problem statement, objectives, significance of the study and organisation of the chapters. Chapter two is the literature review. It covers the concept of climate change, climate variability and extreme events. The chapter further discussed the impact of climate variability. Chapter three of this research report discussed the methodology and procedure for data collection. The chapter presents the demographical responses of Jaman North district. The chapter further presents the research design, research approach, sampling design and sample size. Chapter four present the analysis of data and discussion of findings. Chapter five presents the key findings, conclusions and recommendations from the study.
CHAPTER TWO
LITERATURE REVIEW

2.0 INTRODUCTION

Climate change has many elements affecting biological and human systems in different ways. The considerable spatial heterogeneity of climate change impacts has been widely studied, global average temperature increases mask considerable differences in temperature rise between land and sea and between high latitudes and low precipitation increases are very likely in high latitudes, while deceases are likely in most of the tropics and subtropical land regions (IPCC, 2007). In this regard, there is possible consideration of impacts of changes in climate variability on biological and food systems, with a focus on the tropical and subtropical developing world, where the deleterious developed impacts of anthropogenic climate change are generally projected to be greatest. These less developed countries of the world are already faced with severe food security challenge, with human populations rising unabated throughout the present century (UNDESA, 2013).

In this thesis, consideration is made on the global importance and costs of climate variability and extreme events. There is a review of the major impacts of climate variability and extremes on biological and agricultural systems at a range of scales and on human health and nutrition. Similarly, a linkage is drawn on the increases of climate variability with increasing food insecurity whiles considering the ways in which people deal with climate variability and extremes. The research gaps in relation to both the biophysical and the socio-economic arenas and what needs to done to better understand the impacts of climate variability on human vulnerability and food security, ultimately to
increase the capacity of farmers in the tropics and subtropics to address climate variability and extreme events.

2.1 CLIMATE CHANGE, CLIMATE VARIABILITY AND EXTREME EVENTS

Climate change is inevitably resulting in changes in climate variability and in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events (IPCC, 2012). Climate variability has significant impacts on biological systems and on the smallholders, communities and countries which depend on them. There is considerable literature on the economic costs of climate variability and extremes. Globally, annual damage from large weather and climate events increased eightfold between the 1960s and 1990s; between 1980 and 2014, the cost of extreme weather events mounted to US 1.4 trillion (Mills, 2005).

While there is considerable regional variation, the relative economic burden of climate extremes as a proportion of GDP is substantially higher in developing countries than it is in developed countries up to 8% in most extreme cases. Extreme climate variability has close links with water, agriculture and food security, forestry, health, and tourism, and eventually in countries whose economies depends more heavily on such sector (IPCC, 2012).
2.2 IMPACTS OF CLIMATE VARIABILITY

2.2.1 Biological systems

Notably, warmer climates will generally accelerate the growth and development of plants, but overly cool or hot weather will also affect productivity. Earlier flowering and maturity of several crops have been documented in recent decades, often associated with higher temperatures (Crauford & Wheeler, 2009). Increases in maximum temperatures as in climate or weather can lead to severe yield reductions and reproductive failure in many crops. In maize, each degree day spent above 30°C can reduce yield by 1.7% under drought conditions (Lobell, Schlenker & Costa-Roberts, 2011). Impacts of temperature extremes may also be felt at night, with rice yields reduced by 90% with night temperature of 32°C compared to 27°C. In contrast to the effects of temperature and photoperiod at optimum and suboptimum temperatures, crop response to temperature and photoperiod at super optimal temperature is not well understand (Crauford & Wheeler, 2009).

Climate variability can also be important for yield quality. Protein content of wheat grain has been shown to respond to changes in the mean and variability of temperature and rainfall (Porter & Semenov, 2005), specifically, high temperature extremes during grain fillings can affect the protein content of wheat grain (Hurkman, et al., 2009). At aggregated level as well as at the plot level, rainfall variability is a principal cause of international yield variability. The increase in rainfall variability expected in the future will have substantial impacts on primary productivity and on the ecosystem provisioning services provided by forests and agroforestry systems. Despite the uncertainty surrounding the precise changes, climate variability needs to be taken into account.
In situations where changes in climate and climate variability may be larger, more fundamental changes may occur, particularly if critical thresholds in temperature and/or rainfall are reached (Gornall, et al., 2010). Changes in the nature and timing of the growing season may induce smallholders to grow shorter duration and/or more heat-and drought- tolerant varieties and crops. Most domesticated livestock species have comfort zones between 10 and $30^0\text{C}$; at temperatures below this, maintenance requirements for food may increase by up to 50% and at temperatures above this, animals reduce their feed intake per additional degree of temperature (NRC, 1981).

Drought in grasslands can be a predisposing factor for fire occurrence in many regions (IPCC, 2012), and intensified droughts could exacerbate the problem. Mixed crop-livestock systems are prevalent in much of the developing world (Herrero, et al., 2010) and climate change and changing climate variability in the future may affect the relationship between crops and livestock in the landscapes in many places. In places that will become increasingly marginal for crop production, livestock may provide an alternative to cropping.

Globally, the negative effects of climate change on freshwater systems in terms of changes in quantity and distribution are expected to outweigh the benefits of overall increases in global precipitation due to a warming point. This has the potential to increase flash floods and runoff, and as a result increase soil erosion, diminish soil moisture and increase the risk of agricultural drought (Dai, 2011), as well as increasing the potential for crop losses due to flooding and affecting the dynamics of livestock diseases and their vectors, for instance.
2.2.2 Food systems, health and nutrition

There is little literature on the effects of climate variability and extreme climate events on food systems as opposed to food production. According to a study by Cudjoe and Owusu (2011) in some Ghanaian communities, it is evident how extreme climatic events affect rural food production, transportation, processing and storage. Food security in these communities could be enhanced by increasing farm-based storage facilities; improving the transportation system, especially feeder roads that link food production areas and major markets, providing farmers with early warning systems, extending credit to farmers; and the use of supplementary irrigation. Some cultural practices particularly those that prohibit the consumption of certain foods may reduce the resilience of some individuals and ethnic groups to food systems disruptions.

Climate has both direct and indirect impacts on human health. Extreme heat affects health, especially among the elderly (McMicheal, McMicheal & Woodruff, 2006). Other direct impacts are largely expressed through the interaction of infectious and vector-borne diseases with temperature and precipitation. Human displacement from extreme events, especially floods, could become more frequent with an increase in climate variability. This also often have negative consequences for human health because of crowded conditions with poor sanitation. Diarrheal disease is regularly a problem in such situations (Haines, Kovats, Campbell-Lendrum, & Corvalán 2006). In addition, as inadequate access to health services is already a leading cause of poor health in developing countries, displacement and infrastructure damage from extreme events, especially floods, can exacerbate.
2.3 How changes in climate variability and extremes affect food security

Human populations are vulnerable to the impacts of climate change largely because of the socioeconomic and political context in which they live. This vulnerability to climate change is highly differentiated across geography, income levels, types of livelihood and governance arrangements, among other things.

Human vulnerability can be evaluated in terms of a range of different outcomes such as food security or household income. Thus areas vulnerable to diseases are not necessarily the same as those whose food availability is likely to be negatively affected by changes in climate variability. Food security is a particularly developmental outcome that is highly vulnerable to climate change. This vulnerability is a product of climate change impacts on biological systems, affecting food availability as well as economic and social impacts that affect food utilization, access to food and the stability of food security (Ericksen, 2008).

2.4 Agroforestry, an effective, efficient and fair pathway to achieve food security and agricultural sustainability

Improving and sustaining agricultural production in Africa under conditions of increasing climate variability will require additional attention to environmental sustainability, especially on the crucial neglected roles that trees can play. Agroforestry science guides the integration of trees into crop, livestock and mixed agricultural systems, bringing multiple benefits to both smallholder farms and large agricultural landscapes. This underscores the recognition of the role of trees as key elements to achieving the SDGs.
Against these backgrounds, agroforestry must be viewed as a land use system that seeks to deliver sustainable improvements to food security, through integrating trees with other components of agriculture in multifunctional landscapes.

2.5 Challenges and requirements of successful agroforestry systems

Products and services flowing from the integration of trees within farming systems can contribute to food security, farmer livelihoods and environmental resilience. Trees contribute to food security in Africa through a range of environmental benefits, provision of products and social co-benefits such as increased farm income, restoration and maintenance of biomass and diversity. Trees also enable the restoration of biological corridors between protected forests, maintenance of watersheds, improved soil conservation, availability of timber and fuel wood, as well as reduced pressure on natural resources. Successful agroforestry systems require trees and crops that are respond to local priorities and biophysical conditions, adoption of suitable management practices and integration of those practices into rural livelihood systems.

The recent concept of climate-smart landscapes comes across as a practical way to achieve mitigation, adaptation and agricultural production objectives while ensuring environmental sustainability. In this way, the climate agenda is compatible with the overall sustainable development agenda, as the two cannot be tackled by separate means. It is therefore timely to discuss the landscape approach in the implementation of the SDGs.
The term “Climate-Smart Agriculture” was coined to link agricultural and climate change policy together with a view to reduce the impact of agriculture on climate, while ensuring that agriculture adapts to the effects of changing climate. FAO defines climate smart agriculture as an agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation) while enhancing the achievement of national food security and development goals.

The inclusion of agroforestry in global initiatives on climate change adaptation and mitigation needs to be explicit. The contribution of agroforestry to mitigation strategies, under conditions where adaptation is the highest priority for farmers, needs to take into consideration the differences between development goals and exclusive climate oriented perspectives. Climate change impacts should be thought-out when making recommendations for tree species, as they are long-lived organisms. Most importantly, trees require appropriate care to realize the full potential of agroforestry. Unmanaged trees will be unproductive and may compete with other elements of the farming system.

2.6 Making agroforestry work for the poor

No single approach to food security will be sufficient because of policy failures in controlling demand and supply dynamics of the food system, of which land forms a major component. The success of measures to ensure food security requires a combination of approaches and conditions. It requires the integration of land use systems that improve agriculture and the delivery of ecosystems services. This calls for development practices that integrate and build on the diversity of species and production.
2.7 Systems, the value chains and knowledge systems that is essential for sustainable agriculture.

Agroforestry is a model of an integrated land use approach that can favour increased production using low input technology. However, advance policy actions like governance, gender synergies, secured land tenure, investments and markets need to be in place for agroforestry to deliver sustainable improvements to food security. Policy should also manage the demand side in relation to population growth and changing diets. Although women are involved in value chains, their level of participation is constrained by cultural norms and lack of resources. Mechanisms to engage women in decision-making will help improve the adoption of agroforestry.

Moreover, agroforestry needs to be incorporated with other land management objectives for it to succeed. Addressing biodiversity and sustainable land use within multifunctional landscapes requires integrated policies between the forest and agriculture sectors. One important aspect is to align food security and income generation in sustainability to meet food and cash needs. Market information systems to support product valuation and other aspects such as trade with regional and international markets are key to ensuring efficient interventions through rural collective action.

2.8 Agroforestry and the SDGs in Africa

Research and decision-making are still disconnected in Africa, making it difficult for the achievement of sustainability goals. Agroforestry is not included in government statistics, is undocumented in other sources and mainly classified as agriculture or some type of forestry and not as a separate land use. Judging the possible contribution of agroforestry to rural livelihoods will require more
efforts into assessing the potential of agroforestry systems to support development needs.

2.9 Current knowledge gaps on agroforestry practices

The scholarship on agroforestry practices suggests that agroforestry improves farmer well-being by improving farm productivity and incomes (Garrity, 2006). However, the current literature is largely qualitative. Scholars are calling for more rigorous analyses of agroforestry impacts, particularly on farmer-led agroforestry projects (Scherr & Franzel, 2002a). Most analyses on agroforestry techniques use field experiments led by researchers to assess the effects trees have on improving farm productivity. Relatively few studies analyse farmer-led projects (Scherr & Franzel, 2002a). Farmer-led agroforestry projects are initiatives that allow farmers to choose the type of agroforestry techniques they prefer and put the responsibility of tree seedling survival in their hands. Farmer-led projects are how agroforestry techniques are used under normal circumstances; therefore there is need for more extensive analyses of these types of projects (Scherr & Franzel, 2002a).

At the same time, scholarship on vulnerability is seeking better interdisciplinary evaluations that highlight practices that can improve farmers’ ability to cope with climate-related hazards (Morton, 2007; McLeman & Smit, 2006; Thompson, Berrang-Ford, & Ford, 2007). This literature highlights the importance of community-led, location specific adaptation measures that harness the extensive indigenous knowledge and adaptation techniques of local farmers (Challinor, et al., 2007; Morton, 2007). Many existing analyses have not taken into account the perspectives of these local stakeholders (Pritchett & Woolcock, 2004; Scoones, Devereux & Haddad 2005).
2.10 Conceptual Framework

According to the Intergovernmental Panel on Climate Change (IPCC), climate change vulnerability is “the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes” (Adger et al., 2007). The vulnerability framework of Turner et al (2003) explains how marginalized and rural people are affected by outside shocks and stresses. Turner et al divide a system’s vulnerability into three major components (see Figure 1.1). First, there is the exposure of a system to hazards, which considers the frequency, magnitude and duration of this exposure. Hazards include any threats to the system, both sudden shocks (like floods and droughts) and slow increases in stress on the system (due to soil degradation, increased variation of rainfall patterns, etc).

Second, there is the sensitivity of a system’s current condition to these hazards. Sensitivity is determined by both the environmental and human characteristics that contribute to how a system responds to exposure. Finally, the resilience of a system refers to future actions that can improve its ability to cope with outside hazards. Adaptation measures are actions or processes that help improve farmers’ resilience to hazards and can include governmental policies, NGO programs and autonomous decisions made by individuals or communities. This paper focuses on climate-related hazards that are predicted to increase with climate change. Subsistence farmers will need to substantially improve their resilience to climate-related exposures in order to mitigate the negative consequences associated with future climate change.

Much of the vulnerability literature argues that the most effective way to reduce people’s vulnerability to shocks and stresses is by improving their general well-
being (Adger, et al., 2006; Chambers & Conway, 1991; Conway, 2009). Household sensitivity to shocks depends on numerous compounding factors and cannot be attributed to any single environmental or social factor (Alley, et al., 2007). To improve the well-being through the multitudes of factors that negatively affect rural farmers can help them better deal with climate-related hazards. Scholars suggest a variety of general methods to improving farmers’ lives, including: improving farm productivity, providing off-farm sources of income and improving access to markets (Challinor, et al., 2007; Eriksen, 2008; Kabubo-Mariara & Karanja, 2007; Thornton, et al., 2011).

The climate change literature argues that it will be particularly important to focus on off-farm activities as rain-fed farm productivity becomes less reliable (Armah, Odoi, Yengoh, Afrifa, 2010). Agriculture will remain an important aspect of farmers’ lives, but much of the literature stresses the importance of improving the resilience of future agricultural systems to withstand climatic shocks by changing farming techniques and improving overall productivity (Morton, 2007).

Scholars are also examining specific anticipatory strategies to help people deal with individual climate related shocks (Franzel & Scherr, 2002; Smit & Skinner, 2002; Smit, 2006). These include changes such as planting drought resistant crops and improving flood preparedness. The literature exhibits some tension on whether to focus climate change adaptation measures on these specific adaptation strategies or on the more general well-being improvements outlined above (Brooks & Adger, 2005).
The Turner et al., vulnerability to climate change is used to understand farmers’ vulnerability. Turner et al. divide a system’s vulnerability into three major components: exposure, sensitivity and resilience. Exposure considers the frequency, magnitude and duration to which system is subject to hazards. The term “climate-related hazards” is used to cover both climate-related shocks, such as floods and droughts and longer term climate stresses, such as increasing rainfall variability. The sensitivity of a system is determined by both the environmental and human characteristics that contributed to how a system responds to exposure. Finally, the resilience of a system refers to actions that can improve a systems ability to cope with outside hazards.

Fig 1.1: Vulnerability framework, Adopted from Turner et al. (2003)

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Sensitivity</th>
<th>Resilience</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Components</strong></td>
<td><strong>Human conditions</strong></td>
<td><strong>Impact/response</strong></td>
</tr>
<tr>
<td>Eg. Individuals, households, classes, firms, states, flora, fauna, ecosystems</td>
<td>Social/human capital &amp; endowments</td>
<td>Eg. Loss of life economic, production, soil, ecosystem</td>
</tr>
<tr>
<td><strong>Characteristics</strong></td>
<td>(Population, entitlements, institutions, economic structures)</td>
<td><strong>Adjustment/adaptation/response</strong></td>
</tr>
<tr>
<td>Eg. Frequency, magnitude, duration</td>
<td></td>
<td>Eg. New programs, policy &amp; autonomous options</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental conditions</th>
<th>Coping/response</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural capital/biophysical, endowments</td>
<td>Eg. Extant programs, policy, autonomous options</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER THREE

METHODOLOGY

3.0 PROFILE OF THE STUDY AREA

Jaman North District was created out of the then Jaman south District in 2004 under the Legislative Instrument (LI) 1779 of 2004. The Assembly exists to effectively mobilize resources to spearhead development to improve the living conditions of the people through promotion of agriculture, good governance and development of the human capital base.

The district is located between latitude 7°40” N and 8° 27”N, and longitude 2°30”W and 2° 60” W. The district is physically located to the North-Western part of the Brong Ahafo Region. It shares boundaries with Tain District to the North-East, Jaman South District to the South-West and Berekum District to the South-East. It is bordered on the East to the La Cote d’Ivoire. The district capital, Sampa is located about 119km from Sunyani the regional capital while it is 504 km from Accra, the national capital.

The relief of the district is generally undulating, rising between 150 and 600 meters above sea level. The isolated hills are located around Asuokor, Goka and Suma-Ahenkro. These hills are believed to contain gold deposits and are waiting to be exploited for development of the district. The drainage pattern of the district is largely dendritic and flows in a south and south eastern direction as depicted in Figure 1.1 below. The major river in the district is the Tain whilst a number of minor streams abound in the district. Unfortunately, the water bodies are seasonal which implies that they cannot be relied upon for provision of irrigation to promote continuous and year-round farming.
Climate lying within the wet semi-equatorial region, the district experiences a mean annual rainfall ranging between 120mm to 178mm. The district enjoys bi-modal rainfall patterns with the major one occurring between April to July and the minor one between September and October each year. Relative humidity is generally high, ranging between 70 to 80 percent during the rainy season. The month of August usually experiences a short dry season with the major one occurring between November and March. Average annual temperature is about 260 Celsius.

The vegetation of the district is characterized by two main ecological zones. The major vegetation is the woodland consisting of widely dispersed short trees and grasses/shrubs. This covers the greater part of the total land area of the district. This part of the land is suitable for the cultivation of cashew, yam, cassava, rice, beans and groundnut. The semi-deciduous forest also consists of secondary forest that is suitable for the cultivation of plantain, cocoyam, cassava and yam. It is in this area that major timber species such as Odum, Wawa, Mahogany and Teak harvested in the district are found.

Figure 2.1: Map of Ghana
Source: Ghana Statistical Service, GIS
3.1 AGRICULTURAL ACTIVITIES IN JAMAN NORTH DISTRICT

From the 2010 Population and Housing Census (PHC), households farming activities discussed. These agricultural activities included crop farming, tree growing, livestock rearing and fish farming. The data collected consisted of types of crops cultivated and tree crops grown, livestock types, number and their keepers. The table highlights the type of agricultural activities in Jaman North District pertaining to households in agriculture and type of farming they engaged in.

Table 3.1 Employed Persons in Agriculture, Forestry and Fishing in the Jaman North district

<table>
<thead>
<tr>
<th>PERSONS EMPLOYED IN AGRIC. FORESTRY AND FISHING</th>
<th>MALES</th>
<th>FEMALES</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER</td>
<td>PERCENTAGE</td>
<td>NUMBER</td>
</tr>
<tr>
<td>24,275</td>
<td>11,346</td>
<td>46.7</td>
</tr>
</tbody>
</table>

Source: Ghana Statistical Service, 2010 Population and Housing Census

Table 3.1 gives a breakdown according to the number of persons employed in the Agriculture, Forestry and fishing. The data shows that there are more females employed in this sector as compared to males. Males form 46.7% of those employed while a majority (53.3%) are females. This therefore re-emphasise the need to consider the potential of agroforestry as way of mitigating the effects of climate changes on women in relation to food security in the Jaman North.
Table 3.2 Agricultural activities by households in the Jaman North district

<table>
<thead>
<tr>
<th>AGRICULTURAL ACTIVITIES</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NUMBER</td>
</tr>
<tr>
<td>Households not engaged in Agriculture</td>
<td>2,968</td>
</tr>
<tr>
<td>Households engaged in Agriculture</td>
<td>13,230</td>
</tr>
<tr>
<td>Crop Farming</td>
<td>13,103</td>
</tr>
<tr>
<td>Tree Planting</td>
<td>192</td>
</tr>
<tr>
<td>Livestock Rearing</td>
<td>3,976</td>
</tr>
<tr>
<td>Fish Farming</td>
<td>12</td>
</tr>
</tbody>
</table>

Source: Ghana Statistical Service, 2010 Population and Housing Census

Table 3.2 shows agricultural activities of households in the Jaman North district. The data shows that majority of households 81.7 percent are into agriculture as against 18.3 percent who are not, making the district a hub of agriculture. With 13,230 households who are engaged agriculture, 99.0 percent are engaged in crop farming, 30.1 percent are into livestock rearing. The table also indicates that less than one percent (0.1%) is engaged in fish farming while 1.5 percent are engaged in tree planting. It shows that a larger majority (99.0%) of household in the Jaman North district are into crop farming.

3.2 RESEARCH DESIGN

A case study design was used in research at Jaman North as a strategy of enquiring and exploring how agroforestry activities, the processes involved as well as activities of the individuals involved affect agricultural productivity on the whole. The use of the case study is to also enable the researcher use a mixture of data collection procedures to collect detailed information on agroforestry activities in the Jaman North over the last decade.
3.3 RESEARCH APPROACH

The study adopted a mixed research design. The use of both qualitative and quantitative designs in the study is to be able to take advantage of the strengths of each research design. The use of the mixed methods is to also examine and give understanding to details of potential agroforestry in reducing food insecurity among women in the Jaman North in the face of climate change variability. Both primary and secondary sources of data were used for the purpose of this study.

3.4 DATA SOURCES

Both primary and secondary sources of data were used for the purpose of this study. Primary data will be obtained from the sample units of the sampled population. While secondary data was obtained from the archives of relevant literature, internet among other sources available in the course of the study.

3.5 SAMPLING DESIGN AND SAMPLING SIZE

For a better understanding of the socio-economic, ecological and production systems and solutions to climate change effects on agriculture and food security in the Jaman North, five villages were purposively selected for the study due to limited resources as well as avoiding research fatigue although other villages in the district would have been included in the study. The selection of the villages would be based on the following criteria: village leaders are to provide information related to agroforestry and climate change in their villages, the village contained more than 50 households and ease of access to the study sites.

Probability sampling design was used in selecting individual households for the study. A simple random sampling technique was used in selecting100
households from the selected villages in the district for the purpose of data collection. Out of these households a female farmer each was conveniently sampled as respondents in this study. Thus 100 women farmers were selected for this study. This implies that 20 households from each selected village in the district were selected. However, the selected woman farmer must be practicing agroforestry to qualify to be part of the sample size.

Purposive sampling technique was employed in selecting 3 institutions for the purpose of an in-depth interview. Out of each of these institutions, one officer each was selected for the in-depth interview. Officers that were selected are; a District extension officer, staff of an NGO in the district into agriculture and an executive of women farmer group association.

3.6 DATA COLLECTION

The tools for data collection used for the study were questionnaires for household survey, checklist for observation and focus group discussion and interview guide for in-depth interviews for selected stakeholders in the agroforestry.

3.6.1 Household survey

Household survey was conducted to enable the researcher to quantify how farmer-managed agroforestry interventions have impacted farmers’ well-being particularly that of women in the face of climate related hazards. The topics covered under the household survey include household demographics, crop productivity, women farmers’ constraints, uses of trees, food security and perspectives on climate change with 100 households in January, 2018. Also, observation of household amenities, soil type, soil erosion, total household size
was done. The selection of the households was done based on their involvement in agroforestry farming, since most of the farmers including the women in the district are involved in agroforestry activities.

3.6.2 In-depth interviews

In-depth interviews were conducted with 10 farmers in the district. The questions will focus on observed changes in climate, farming practices and productivity constraints, agroforestry practices and its potential in reducing the effects of climate variability on food security among the women and the communities at large. Interviews were conducted with five women leaders who are engaged in active agroforestry farming in the community. The remaining five would be conducted with farmers identified as been successful in their farming endeavours.

3.6.3 Focus Group Discussion

Selection of focus group participants was based on random sampling using a list of households in the selected villages from the district. Invitations of the participants were issued to 10 households either orally or in writing. The target size for the focus group discussion was 10 individuals. No household was allowed to participate in more than one focus group. In the case where there are an appreciable number of households not actively farming, the list was reviewed and removed those households before the remaining were used for the random selection. Opportunity was given to other people to join the focus group, especially elders or decision makers in some instances. Raw data from each focus group was recorded by the research team with the support of a study guide. Information gathered was then be analysed to draw conclusions and recommendations from the study.
The essence of the focus group discussion to be held is to aid the outcome from the interviews and survey. Apart from the selected households from the district, focus group discussions were also held with two women farming groups in the district. Participants were allowed to share their experiences on how climate variability has affected their agricultural activities over the years as well as the steps taken to mitigate these effects particularly in ensuring food security. Participants also shared problems facing their households as well as the outcome of agroforestry in the district.

3.7 ACCESSING AND USING CLIMATE INFORMATION

To investigate access to and use of daily weather and seasonal climate forecast, two focus groups were formed. The researcher took one each for adult females (10), and female youth (8). Seasonal calendars were used to understand farming activities in relation to weather information. Daily and seasonal forecasts provided by national metrological services would be served and discussed.

3.8 DATA ANALYSIS

The field observation, interview notes and focus group discussion were analysed by categorizing them into themes and inputting them into computer with the help of computer software known as Statistical Package for Social Sciences (SPSS) for both qualitative and quantitative analyses. The SPSS software was used by the researcher to construct descriptive statistics to explain some variables.
CHAPTER FOUR
RESULT AND DISCUSSION OF FINDINGS

4.1 DATA PRESENTATION AND ANALYSIS
The following section entails the presentation of results and analysis of the study on the potential of Agroforestry in reducing the effects of climate variability on food security among women in the Jaman North. The results are shown in and the analysis conducted in percentage distributions and regression analysis.

4.1.1 Demographic Information
Figure 4.1 show information about the age, marital status, education and number of children etc. of the respondents.
Table 4.1: *Descriptive Statistics: Demographic Profile of Respondents (N=100)*

<table>
<thead>
<tr>
<th>Profile</th>
<th>Item</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>20-30</td>
<td>8</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>31-40</td>
<td>22</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>41-50</td>
<td>58</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>+50</td>
<td>12</td>
<td>0.12</td>
</tr>
<tr>
<td>Marital Status</td>
<td>Married</td>
<td>62</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td>Unmarried</td>
<td>8</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Divorced</td>
<td>12</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>Widowed</td>
<td>18</td>
<td>0.18</td>
</tr>
<tr>
<td>Level of Education</td>
<td>No Edu.</td>
<td>62</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td>Prim.</td>
<td>22</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>JHS</td>
<td>10</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>SHS</td>
<td>6</td>
<td>0.6</td>
</tr>
<tr>
<td>Number of Children</td>
<td>One</td>
<td>6</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>Two</td>
<td>18</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>Three</td>
<td>28</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>+Four</td>
<td>48</td>
<td>0.48</td>
</tr>
<tr>
<td>Land Size</td>
<td>One</td>
<td>40</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>Two</td>
<td>40</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>Three</td>
<td>16</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>+Four</td>
<td>4</td>
<td>0.4</td>
</tr>
<tr>
<td>Land Turner</td>
<td>YES</td>
<td>6</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td>94</td>
<td>0.94</td>
</tr>
</tbody>
</table>


4.2 OBJECTIVE ONE: THE ROLE OF WOMEN IN AGRICULTURAL PRODUCTION

Table 4.2a below seeks to identify the some of the role of women in agricultural production, especially their role in agroforestry.
Table 4.2: The Role of Women in Agric Production

<table>
<thead>
<tr>
<th>Measurement Scale</th>
<th>(SA)</th>
<th>(A)</th>
<th>(NS)</th>
<th>(D)</th>
<th>(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land preparation, sowing and management of farm</td>
<td>84</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Irrigation and supply of organic manure</td>
<td>88</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Keeping of live stocks</td>
<td>80</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Paid labourers</td>
<td>72</td>
<td>28</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Labour supervision and post-harvest operations</td>
<td>64</td>
<td>36</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>


From, Table 4.2 shows that 84 percent and 16 percent of the respondents strongly agreed and agreed respectively to the statement that women play the role of land preparation, sowing and management of farm in agroforestry. Majority of the respondents strongly agreed that women play the role of managing their own farms.

Similarly from the same table, 88 percent and 12 percent of the respondents strongly agreed and agreed respectively to the statement that women play the role of proving irrigation and the supply of manure to the farms. Most of the respondents strongly agreed that women provide irrigation and manure to the farm to enhance agroforestry.

Accordingly, from the table, 80 percent and 20 percent of the respondents strongly agreed and agreed respectively to the statement that women play the role of keeping livestock’s. The results suggest that majority of the respondents strongly agreed that women rear animals to improve agroforestry in the district.
Also from the table, 72 percent and 28 percent of the respondents strongly agreed and agreed respectively to the statement that women provide labour for other people engaged in agroforestry. The results suggest that majority of the respondents strongly agreed that women rear work as labourers on other people’s farms to enhance agroforestry in the district.

Lastly from the table, 64 percent and 36 percent of the respondents strongly agreed and agreed respectively to the statement that women play the role of labour supervision and post-harvest operations to support agroforestry. The results suggests that majority of the respondents strongly agreed that women play the role of labour supervision and participation in post-harvest operations.

4.3 OBJECTIVE ONE: IMPACT OF WOMEN ROLES ON AGRICULTURE AND FOOD SECURITY

Table 4.3 seeks to measure the effect of women’s roles on agriculture and food security. Below is the regression analysis table for the impact of women’s roles (independent variable) on agriculture and food Security (dependent variable). The measured women’s roles variables are Crop growing, Livestock rearing, Paid labour and Post-harvest operations, and the dependent variable is Food Security.

Table 4.2a Regression Coefficients for the Impact of Women Roles on Food Security.
Table 4.2a Regression Coefficients for the Impact of Women Roles on Food Security

<table>
<thead>
<tr>
<th>Variables</th>
<th>R</th>
<th>( R^2 )</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Unstandardized Coefficients Beta</th>
<th>Standardized Coefficients Beta</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop growing</td>
<td>0.668</td>
<td>0.446</td>
<td>0.396</td>
<td>.60146</td>
<td>0.755</td>
<td>0.668</td>
<td>0.01</td>
</tr>
<tr>
<td>Animal rearing</td>
<td>0.490</td>
<td>0.240</td>
<td>0.211</td>
<td>.67547</td>
<td>1.293</td>
<td>0.490</td>
<td>0.00</td>
</tr>
<tr>
<td>Paid labour</td>
<td>0.643</td>
<td>0.414</td>
<td>0.324</td>
<td>.61725</td>
<td>1.368</td>
<td>0.643</td>
<td>0.00</td>
</tr>
<tr>
<td>Post-harvest operations</td>
<td>0.723</td>
<td>0.523</td>
<td>0.406</td>
<td>1.73245</td>
<td>1.134</td>
<td>0.723</td>
<td>0.02</td>
</tr>
</tbody>
</table>


From the table above, the calculated R shows the degree of impact the Roles of Women has on Food Security, where the sign of beta shows the positive direction of the effect. The \( R^2 \) shows the amount of impact the independent variables have on the dependent variable, that is, the amount of variation each individual variable account for. This also means there could be other factors that could account for the \( R \) value. The adjusted \( R \) square shows the amount of loss in R that may occur given a repetitive test on another sample.

The table shows that the women role of “Crop growing” has a strong positive relationship with food security with a 67 percent impact. Also about 45 percent of the impact of women role on food security is accounted for uniquely by the “Crop growing” variable (\( R^2 = 0.446 \)).

Similarly, the table shows that “Animal rearing” has about 49 percent positive effect on “Food security” and indicating that 24 percent of the effect of women role In Animal rearing on Food security could be uniquely explained for by their role of “Animal rearing”.

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Furthermore, “Paid labour” has about 64 percent positive effect on “Food security”. The result also suggests that 41 percent of the women’s role of Paid labour effect on Food security could be accounted for uniquely by their role of “Paid labour”.

Lastly the table shows that “Post-harvest operations” positively impacts on “food security” by about 72 percent, and also suggesting that about 52 percent of the Post-harvest operations effect on “food security” could be accounted for uniquely by the “Post-harvest operations” variable.

Table 4.2b Model Summary For Impact of Women Role on Food Security

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.681</td>
<td>0.464</td>
<td>0.402</td>
<td>0.01735</td>
</tr>
</tbody>
</table>


Table 4.3b shows the model summary for the effect of women role (in agriculture) on food security. Accordingly, the table suggests that overall, women role has about 68 percent positive influence on food security (R= 0.681). And the predictors (Crop growing, Livestock rearing, Paid labour and Post-harvest operations) explain about 46 percent of the model outcome ($R^2=0.464$). The study findings therefore suggest that the role women play in agriculture has a positive effect on food security.
4.4 OBJECTIVE TWO: COPING STRATEGIES ADOPTED BY WOMEN AGAINST CLIMATE RELATED HAZARDS

Table 4.3 below seeks to examine the strategies adopted by women in agriculture in coping with climate variability shocks.

Table 4.3 Coping Strategies Adopted by Women against Climate Related Hazards

<table>
<thead>
<tr>
<th>Measurement Items</th>
<th>SA</th>
<th>A</th>
<th>NS</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation of rain water and construction of hand dug well</td>
<td>92</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Diversification of farming (tree planting, livestock rearing)</td>
<td>80</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>In-season adjustment of crops (drought tolerant crops)</td>
<td>66</td>
<td>34</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Soil fertility management (without fertilizer usage)</td>
<td>63</td>
<td>37</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Casual labor</td>
<td>71</td>
<td>29</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Borrowing and selling of other assets</td>
<td>23</td>
<td>77</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>


To be begin with, Table 4.3 shows that 92 percent and 8 percent of the respondents strongly agreed and agreed respectively to the statement that women conserve rain water and construct hand dug well as a strategy in coping with climate related shock. Majority of the respondents strongly agreed that women harvest rain water a strategy to manage the vulnerability to climate variability hazard.
Also the table shows that 80 percent and 20 percent of the respondents strongly agreed and agreed respectively to the statement that women rely on diversification of farming (like rearing of animals) as a strategy to cope with the vulnerability to climate change. Most of the respondents strongly agreed that women diversify their farming by rearing of animals and practicing agroforestry to manage the shocks associated with climate change.

Again, the table shows that 66 percent and 34 percent of the respondents strongly agreed and agreed respectively to the statement that in-season adjustment of crops strategy to cope with climate related exposure. The outcome suggests that majority of the respondents strongly agreed that women adopt in-season adjustment of crops as a strategy to cope with climate variability shocks.

Accordingly, the table shows that 63 percent and 37 percent of the respondents strongly agreed and agreed respectively to the statement that women adapt soil fertility management strategy in coping with climate related hazard. Majority of the respondents strongly agreed that women result to the strategy of soil fertility management, without fertilizer usage.

In addition, the table shows that 71% and 29% of the respondents strongly agreed and agreed respectively to the statement that casual labour is a strategy adopted by women to cope with climate change hazard. Majority of the respondents strongly agreed that women provide casual labour as a strategy to cope with adverse climatic shocks.

The table finally shows that 23 percent and 77 percent of the respondents strongly agreed and agreed respectively to the statement that women borrow and
sell their asset as a strategy to cope with climate related exposure. The results suggests that majority of the respondents agreed that women borrow and sell their asset to manage adverse climatic shocks.

4.5 OBJECTIVE THREE: THE ROLE OF AGROFORESTRY IN IMPROVING ADAPTABILITY TO CLIMATE-RELATED HAZARDS

Table 4.4 below seeks to examine the role of agroforestry practices in improving women adaptability to exposure to climate-related hazards.

Table 4.4: The role of agroforestry in improving adaptability to climate-related hazards

<table>
<thead>
<tr>
<th>Measurement Items</th>
<th>SA</th>
<th>A</th>
<th>NS</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growing trees to supplement agriculture income</td>
<td>88</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Diversifying farming with livestock keeping</td>
<td>82</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Providing casual labour in nursery and tree planting</td>
<td>77</td>
<td>23</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Education on agroforestry by the government</td>
<td>67</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Receiving incentives from the government and NGO to practice agroforestry</td>
<td>65</td>
<td>35</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 4.3 shows that 88 percent and 12 percent of the respondents strongly agreed and agreed respectively to the statement that women grow trees to supplement agriculture income as a way of adapting to climate-related hazards. The outcome suggest that majority of the respondents strongly agreed that women engage in tree planting, as a form of agroforestry, to improve upon their source of income to adapt to climate variability shocks.

Similarly from the same table, 82 percent and 18 percent of the respondents strongly agreed and agreed respectively to the statement that women diversify farming with livestock keeping reducing the impact of climate change hazards. The findings suggest that most of the respondents strongly agreed that women diversify their agriculture production to cope with climate related shocks.

Accordingly, from the above table, 77 percent and 23 percent of the respondents strongly agreed and agreed respectively to the statement that women provide casual labour in nursery and tree planting in exchange for income to manage climate related hazards. The outcome of the study therefore implies that majority of the respondents strongly agreed that women work on other people’s agroforestry farms to earn a living to secure themselves against climate variability risks.

Also from the above table, 67 percent and 33 percent of the respondents strongly agreed and agreed respectively to the statement that women receive education and training on the practice agroforestry from the government to mitigate hazards related to climate change. The outcome of the study therefore indicates that majority of the respondents strongly agreed that the education and training that women receive help them cope with climate variability shocks.
Lastly from the above table, 65 percent and 35 percent of the respondents strongly agreed and agreed respectively to the statement that women receiving incentive from the government and NGOs to practice agroforestry to mitigate the shocks associated climate change. The findings suggest that most of the respondents strongly agreed that government and NGOs support women in engaging in agroforestry which serves as a security against climate variability hazards.

### 4.6 DISCUSSION OF FINDINGS

*Discussion of Objective One: The Role of Women in Food Production*

The study revealed that women played significant role in food production in the study area. Their role could be grouped in three categories, including role in farming, livestock keeping and provision of paid labour.

Women play a vital role in land preparation, sowing and management of farms. They supplement this with the conservation of water for irrigation and the supply of organic manure. These role played by women improve food security in the study area. About 52% of women are engage in agriculture in the study area compared with men (Jaman North District 2016), but their roles are constrained by caring for the children, managing homes, limited access to land, and discrimination among many others. The role played by women in food agricultural production are often not recognized by society as noted Akinnagbe and Irohibe (2014) in their study on the role of women agriculture in Africa.

Women Keep live stocks to diversify their agricultural activities. Rearing of fowl and goats are common in the study area. The women from focus group
discussion explained that rearing of poultry and goats is less laborious and less expensive in managing. This finding also confirms the outcome from the studies Akinnagbe and Irohibe (2014) which reviewed multiple empirical literature that acknowledged the role women play in livestock rearing to improve food security and supporting homes in the rural economy. Sometimes women are the head of their families having to provide for their dependents and taking care of the home at the same time.

Women also provide labour for income or in exchange of food stuff and animals to support their family. This role of women by supplying labour help increases food production in the study area. This allows the owners of the farms, usually men, to have free time to attend to other income earner ventures. This findings is confirms the study by Cooper, Dimes, Rao, Shapiro, Shiferaw and Twomlow (2008) who observed in their study that women engage in paid labour to supplement their income as agriculture is mostly the main source of employment for women in the rural areas.

Women also play the role of labour supervision and participating in post-harvest operations in the study area. As noted earlier, because of the limited access to employment opportunities, working on the farm is the main income earning avenue for most women in the rural setting. The men engage the women in this role so that they can have the opportunity to work in other ventures, which women more often have limited opportunities there.

The study shows that women play critical role in agricultural production and food security in the rural setting. Though the role of women are constrained by their by caring for the children, managing the home and limited access to land
among others, women are major producers food in the rural area. Their ability to continue farming in the face of these limitations re-echoes their significant contribution to the development of the rural economy. They need to be supported and protected by the legal regime for them to intensify the roles they play in their family and society.

**The Impact of Women’s Role in Agriculture on Food Security**

The results from the study shows the model summary for the effect of women role (in agriculture) on food security is significant. Accordingly, the table suggests that overall, women role has about 68% positive influence on food security (R= 0.681). And the predictors (Crop growing, Livestock rearing, Paid labour and Post-harvest operations) explain about 46% of the model outcome (R^2=0.464). The study findings therefore suggest that the role women play in agriculture has a positive effect on food security.

The study shows that women play critical role in agricultural production and food security in the rural setting. Though the role of women are constrained by their by caring for the children, managing the home and limited access to land among others, women are major producers food in the rural area. Their ability to continue farming in the face of these limitations re-echoes their significant contribution to the development of the rural economy. They need to be supported and protected by the legal regime for them to intensify the roles they play in their family and society.

Tree planting in the Jaman North District is a viable alternative to supplement crop farming and livestock rearing to increase women vulnerability to climate related shocks. Evidence from the study suggests that if women farmers are
given the necessary support and training, the rural economy could benefit substantially from the contribution of women, who are the major providers of agricultural production.

Discussion of Objective Two

The Coping Strategies Adopted to Mitigate the Exposure to Climate Change Hazard

The study also found the current coping strategies adopted by women with the exposure to climate related hazards. The women conserve water during the rain seasoning and use for irrigating their farms. Some of the women revealed during the focus group discussion that they result to the digging of hand dug wells on farm to manage the shocks associated with climate change harvesting rain only lasts as long as the size of the storage reservoir so that strategy of coping with seasonal draught could be a bit problematic. This finding corroborates the findings from the study of Ahenkan, and Boon (2010) on the cocoa farmer’s perception and coping strategies in Ghana. The study noted that due to the nature of the rain fed farming systems practiced, farmers conserve water in the raining season to support their crops which depend on rain fall.

The study revealed that women noted they diversify agricultural production and is the most effective strategy in coping with climate variability hazards. This could be explained for by the nature of the system of farming in the Jaman North district, which is mainly rain fed. An empirical study of Morton (2007) also confirmed this outcome as a very common approach by women in reducing vulnerability to climate change hazards.
Related to this strategy are women adapting to in-season adjustment of crops and this finding is consistent with the study conducted by Codjoe, Ocansey, Boateng and Ofori (2013) on climate change awareness and coping strategies of cocoa farmers in rural Ghana. In this strategy the women plant crops according to the season of the farming year. They mostly plant drought tolerant crops during the dry season and plant crops which rely heavily on rain in the raining season. This strategy is efficient and strategic as it requires a proactive approach to farming. Combining this strategy with the Soil fertility management strategy, without fertilizer usage, could significant reduce women’s vulnerability to climate variability exposure. As observed in the focus group discussion, women see this strategy as less expensive and efficient to some extent, as they can have the cattle dung for free.

In severe circumstances in a particular season, women with no option or who are not prepared for the climate change exposure, result to selling their assets and borrowing funds from other sources. This is consistent with the findings from Cooper et al. (2008) on climate change and its effects on farmers Sub Saharan African region. This strategy is the least efficient as the women could be exposed to subsequent shocks in the near future, noted by the authors. The more efficient strategy of dealing with climate change shock is the provision of paid laid to other farmers. This strategy is efficient in that the women could reduce the severity of the impact of the climate related shocks. In short, a combination of these strategies would be more efficient in reducing the women vulnerability to climate related shocks.
Discussion of Objective Three

The Role of Agroforestry in Improving Adaptability To Climate-Related Hazards

The results from the study shows that women engaging in agroforestry help them adapt with climate change related hazards. Some of the women engaged in tree planting along the plating of arable crops and tree crops to supplement their income and position them well against the shocks associated with climate variability. This is a good practice as expects and scholars have called on people from sub-Saharan Africa to diversify their agricultural production to generate income and reduce poverty among women (see Matlon & Kristjanson, 1988). Though this is a good climate related adaptability strategy, it needs to be supplemented by other forms of strategies irrigation for people to realize the full potential of agroforestry, as noted by Cooper et al. (2008).

Accordingly, the outcome from the study also shows that women also diversify their farming by rearing livestock and providing labour on other people’s farm. These findings corroborates the outcome from the study of Codjoe et al. (2013) which noted diversification of farm activities including provision of labour for others is an effective way of minimizing the impact of climate variability shocks. In the focus group discussion held with the people of the study area, they observed that this form of agroforestry, especially keeping cattle provide readily available feed for the animals on a portion of the farm land. This is a less expensive and easier way of diversifying agricultural production.

The support provided by government and NGOs in the form of education and training and provision of farm supplies have also been noted to be encourage women to practice agroforestry. This support and other initiatives targeted
towards agroforestry have helped women to cope with climate change related hazards. This finding is in agreement with the study of Cooper and co (2008) who noted that governments across Sub-Saharan Africa have provided the needed support and training for farmers in rainfed agric environment to diversify their agriculture production by engaging in agroforestry.
CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 SUMMARY

This study focused on the potential of agroforestry in reducing the effect of climate variability on food security among women in the Jaman North District. Using a mixed research methods, a purposive sampling technique was used to select five villages and hundred (100) respondents from these villages in the District for the study.

The researcher sought to identify the basic characteristics of the 100 respondents engaged in the study. It emerged from the study that majority of the respondents are between the ages of 40-50 years, 62 percent of the respondents are married, with 62 percent with no formal education. It also emerged from the findings that majority of 48 percent of the respondents have more than four children, with 40 percent having two acres of land and these individuals (94%) having ownership title to the lands.

There were three objectives in this research. Objective one investigated the roles of women in agricultural production and on food security. Objective two assessed the coping strategies adopted by women in Jaman North to mitigate the impacts emanating from exposure from climate change. The last objective, objective three examined the role of agroforestry practices in improving women adaptability to the exposure to climate-related hazards in the Jaman North

Regarding objective one “roles of women in agricultural production and on food security”, the result showed that women in agricultural production play significant roles such as land preparation, sowing and management of farm in agroforestry. The result also showed that those women provide irrigation and
manure to the farm, rear animals and serve as labourers on other people’s farms. Lastly, the result also showed that women provide labour supervision and participation in post-harvest operations.

Regarding the role of women in agricultural and food security, the result showed a significant effect of women’s role in agriculture on food security in the District. The result showed that despite the constrained faced by women in the district in caring for the children, managing the home and limited access to land among others, they continue their farming activities which re-affirms their contribution to food security and development of the rural economy.

Regarding Objective two, the study examined the coping strategies adopted to mitigate the exposure to climate change hazard. The study found that women conserve water by digging of hand dug wells during the rainy season and use it in irrigating their farms and managing their shocks. Again, the result showed that women diversify agricultural production strategies such as in-season adjustment of crops to cope with climate variability hazards. They result also found that women, as a strategy plant drought tolerant crops during the dry season and plant crops which rely heavily on rain in the raining season. Lastly on the coping strategies, the result revealed that women with no option or who are not prepared for the climate change exposure, result to selling their assets and borrowing funds from other sources.

The third objective of the study revealed that women engage in agroforestry to adapt with climate change related hazards. The result found that women plant trees at the plating of arable crops to fight against the shocks associated with climate variability and also supplement their income. Again, women diversify
their farming by rearing livestock and providing labour on other people’s farms as a strategy to cope with the shocks. Last the result showed that government and NGOs support encourage women to practice agroforestry.

5.1 CONCLUSIONS

Based on the findings from the study the following conclusions are made.

a. Women in agricultural production in Jaman North play the role of managers on their own farms, provide irrigation and manure to the farm, rear animals, and serve as labourers on other people’s farms by supervising and participating in post-harvest operations.

b. Despite the constrained of women in caring for the children, managing the home and limited access to land among others, women continue farming to ensure food security in Jaman North District.

c. In order to cope with exposure to climate change hazard, women in Jaman North conserve water by digging hand dug wells, use irrigation systems, and cultivate drought tolerant crops during the dry season and heavy crops in the raining season.

d. Women with no option and/or not prepared for the climate change exposure, sell their assets and borrow funds from other sources in order to cope with exposure to climate change hazard.

e. Women plant tree at the planting of arable crops to fight against the shocks associated with climate variability and also supplement their income.
f. Women diversify farming by rearing livestock and providing labour on other people’s farm to help them adapt with climate change related hazards.

g. Lastly government and NGOs support was found to encourage women to practice agroforestry

5.2 RECOMMENDATIONS

The following recommendations have been made for policy and practical implications. It emerged from the result that women work as if they are head of their families having to provide for their dependents and taking care of the home at the same time. The studies recommends that men, as a social responsibility must provide support for their wives. These supports may include financial assistance, farm hand among other. These supports will help the women to expand their farms and cater for the entire family in a more comfortable way.

It emerged from the result that, women play critical roles in agricultural production and food security. The finding suggests that if women farmers are given the necessary support and training, the rural economy could benefit substantially from the contribution of women. The study recommends that government and rural authorities must prove support and protection by providing a legal framework for the activities of these women. This legal support will encourage them to intensify the roles they play in their family and society.

It emerged from the study that women with no option or who are not prepared for the climate change exposure, sell their assets and even borrow funds from other sources. It is therefore recommended that women in agriculture should be provided with alternative strategies that will help them adjust their farming
periods to avoid exposure to climate change. In the case of eventualities, government must be quick to support these women in order to keep them in production. Lastly, community farming associations can be instituted to help formalise paid labour to other farmers as a strategy to help vulnerable farmers deal with climate change shock.

It emerged from the study that women have diversified strategies to improve their adaptability to climate related hazards. The study recommends that Government and NGOs provide less costly support in the form of education and training and provision of farm supplies to help women to practice agroforestry. Women should be encouraged to rear animals such as cattle, provide labour to other farms, plant trees along the plating of arable crops and tree crops to supplement their income respond positively to the shocks of climate variability.

5.3 FUTURE RESEARCH DIRECTION

In addition, the researcher used a convenience sampling technique which makes generalisation of the findings difficult. A probability technique such as simple random can be used to undertake future research which will allow the researcher generalise the findings to other districts with similar characteristics. This study was context in Women in Jaman North District. The study can also be replicated in other district and regions in order to form the basis for comparison.
6.0 REFERENCES


APPENDIX A: STRUCTURED INTERVIEW AND QUESTIONNAIRE

**Topic:** The potential of Agroforestry in reducing the effects of climate variability on food security among women in the Jaman North

**Section A: Demographic Characteristics**

Name of Community:

Type of settlement: Rural { } Peri-urban { } Urban { }

Date of Interview: .................................................................

1. Age{ }

3. Marital Status a. Married ( ) b. Unmarried ( ) c. Divorced ( ) d. Widowed ( )

4. Number of Children{ }

5. Length of stay in community{ }

6. Household size{ }

7. What material was used in building your house? a. Mud ( ) b. bricks ( ) c. cement blocks ( )

8. What type of roofing was used in roofing your house? a. Zinc ( ) b. Thatch ( ) c. Bamboo ( )

9. Land size (acres) .................................................................

10. Holds title to land. YES ( ) NO ( )


12. Level of education. a. Primary school { } b. Secondary school { } c. Tertiary { } d. No formal education { } e. Other. Please specify.................................

13. Do you have livestock? a. Yes ( ) b. No ( )

14. What is the total number of livestock at your disposal? ................................

**Section B: Knowledge on climate change climate variability.**

15. Do you think the weather conditions have changed over the past 10 years?
   a. No b. Yes c. Do not know

16. What do you think is the cause of this change? a. God/gods b. Deforestation
c. Bush burning d. Increased population e. Others
   (specify).................................
17. Temperature has changed over the past 10 years? a Strongly disagree b do not know c Strongly agree.

18. What do you think is the cause of these changes? a. God/gods b. Deforestation c Bush burning d. Increased population e. Others (specify)......................

19. How has it changed over the past 10 years? a. It has decreased b. it has increased c. Don’t Know d. No change

20. Rainfall amount has changed over the past 10 years a. Strongly disagree b. do not know c. Strongly agree

21. What do you think is the cause of these changes? a. God/gods b. Deforestation c. Bush burning d. Increased population e. Others (specify)......................

22. How has it changed over the past 10 years? a. It has decreased b. It has increased c. Don’t Know d. No change

23. What measures do you take to ensure increased productivity? (tick all that apply) a. Irrigation ( ) b. Maintenance of soil fertility ( ) c. Pest control management ( ) d. Conserve soil from erosion ( ) e. Conservation of water ( ) f. Others (specify)........................................................................................................

24. How has agricultural practices changed?

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

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

25. About how many years ago did you start witnessing changes in agriculture?

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

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

C. Women’s role in agricultural production and impacts of climate change on agriculture and food security

26. What is the main driver of changing agricultural practices in the district? a. changing rainfall patterns ( ) b. declining soil fertility ( ) c. labor shortages due to urban mitigation

27. What adaptation strategies do you pursue in order to cope with perceived changes in climate patterns? tick all that apply

a. Intercropping ( )
b. fertilizer and pesticides ( )
c. early planting ( )
d. adopting drought-resistant varieties and making adjustments in the timing of weeding and harvesting ( )
e. crop rotation ( )
f. Mixed farming (integrating crops, livestock and trees) ( )
g. using improved seeds ( )
h. Soil and water conservation ( )

28. With respect to adoption of soil and water conservation practices/soil fertility enhancement, are women facing challenges? a. Yes ( ) No ( )

29. If Yes, please identify the challenges

………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………

30. Is soil fertility enhancement with livestock manure and inorganic fertilizers practiced? a. Yes ( ) No ( )

31. If YES, is it exclusively practiced by men or women are included? a. Men b. Men and women

32. Are there specific interventions from organizations, NGOs to support agriculture in the District including government extension and advisory services? a. Yes ( ) No ( )

33. If YES, what specific agricultural interventions/support have you benefitted from in the past 12 months?
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………

34. Between men and women, which of them mostly travel outside the district for marketing and for purchasing improved seeds?

………………………………………………………………………………

35. For the past 12 months, have you benefitted/attended any developmental training in relation to agriculture to acquire new ideas? a. Yes ( ) No ( )

D: Current coping strategy with exposure to climate related hazards

36. What strategy (ies) have you adopted due to the exposure to climate related hazards? Tick those applicable
a. Reduce quantity, quality or number of meals ( )
b. Help from government, NGOs, church ( )
c. borrow money ( )
d. casual labor ( )
e. sell possessions or livestock ( )
f. consume seeds ( )
g. consume or sell fruits from trees ( )

37. Due to climate-related hazards experienced, does your household experience intense periods of hunger? a. YES ( ) b. No ( )

38. If YES, for how long and during which season?

………………………………………………………………………………
39. How do you intend to improve household’s food security, especially during periods of outside shocks?
   a. interest in opportunities to start small business ventures ( )
   b. obtaining credit to purchase farm implements to improve their farm ( )
   c. interest in opportunities to improve agricultural knowledge ( )
   d. to learn about alternative income opportunities as other indirect pathways to improve food security ( )

E: Well being of women in adapting to climate related hazards

40. Which of these is a major constraint in achieving well-being? a. weather ( )
    b. farm inputs and implements ( ) c. environmental/soil fertility ( )
    d. health of household ( )

41. To reduce climate change vulnerability, what strategy (ies) have you adopted to cope with the shocks and stresses associated with it?
   a. improve off-farm incomes ( ) b. diversify income sources ( )
   c. improve farm productivity ( )

42. During times of stress or shocks, how long is your household food secure?
   a. 1 month ( ) b. 2-3 months ( ) c. 4-5 months ( ) d. 6 months ( ) e. none ( )

43. Enumerate (3) benefits you derive from planting trees on your farm.
   ........................................................................................................
   ........................................................................................................
   ........................................................................................................

44. To check soil erosion on your farm, what farming method have you adopted?
   ........................................................................................................
   ........................................................................................................
   ........................................................................................................

45. Does your involvement in agroforestry provide substantial labor savings to women household members? a. YES ( ) b. NO ( )
46. If YES, how?
   ........................................................................................................
47. As part of coping options to farmers during exposure to drought and floods, do agroforestry products provide alternatives to household food supply? a. YES ( ) b. No ( )
48. If YES, how?
   ........................................................................................................
49. How many hours do you spend weekly on fuel wood collection?
   ........................................................................................................
50. Does your household purchase fuel wood? a. YES ( ) b. No ( )
F: For Respondents who engage in Farming as Livelihood Option

51. How did you acquire your farmland?
   a. Inheritance/family land ( )
   b. Renting ( )
   c. Gift ( )
   d. Purchasing ( )
   e. Temporary Borrowing ( )
   f. Share cropping ( )

52. Do you face difficulty accessing land? Yes ( ) No ( )

53. If yes, how……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

54. Where do you normally farm?
   a. Backyard ( )
   b. Along river banks, drains and water catchment areas ( )
   c. Open spaces reserved for future use ( )
   d. On building sites ( )
   e. Others (specify)……………………………………………………………………………………

IN-DEPTH INTERVIEW GUIDE

1. What are some of the gender based constraints that women face in the agricultural sector?
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………

2. How do women contribute to food security in Jaman North?
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………

3. In your opinion, how does climate-smart agriculture (agroforestry) seek to deal with the interlinked challenges of climate change mitigation and socio-economic inequalities?
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………

4. In your opinion, how are rural women poor in Jaman North?
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
5. What could be done to address the challenges associated with climate change?

6. How can agroforestry be made gender-responsive in your opinion?

7. How does climate change impact agriculture in Jaman North from your perspective?

8. Give 2 examples of current and possible future impacts and vulnerabilities associated with climate variability and climate change vis-à-vis agriculture and food security in Jaman North?

9. How might agroforestry be relevant for the betterment of livelihoods of poor farmers, especially women in Jaman North?

CHECK LIST FOR FOCUS GROUP DISCUSSION

The focus group discussion will cover the following topics:

- Observed changes in climate
- Farming practices and productivity constraints in Jaman North
- Agroforestry practices among women in Jaman North
- Future goals of women engaged in agroforestry in Jaman North
- How households cope with drought in Jaman North.